WILLIAMSON RIVER DELTA PRESERVE
WETLAND VEGETATION MONITORING 2000-2004

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Emergent vegetation in Field 5, October 2003.

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

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1. Introduction

In the 19th century, vegetation at the Williamson River Delta was composed of a mosaic of wetland and upland plant communities that typified much of the Upper Klamath Basin at that time. Historic accounts of vegetation mapped by Christy (1996) show that four plant communities dominated the delta: willow swamp, tule swamp, wet prairie, and greasewood/ bunchgrass prairie. By the 1940's, however, wetland drainage and levee construction transformed the delta into agricultural fields and pasture for cattle grazing.

The Nature Conservancy (TNC) purchased the northwest portion of the Williamson River Delta in 1996 and the south portion of the delta in 1999, with the objective of restoring wetland habitat for two endangered fish species and improving surface water quality in Upper Klamath Lake. Initial restoration efforts began in 1998 and consisted of seasonally flooding the former agricultural fields. In 2000 and 2003, three small portions of the preserve (Campfields, Riverbend, and South Marsh) were hydrologically reconnected to Agency Lake, the Williamson River, and Upper Klamath Lake, respectively, by breaching sections of levee. The Nature Conservancy's long-term goal is to re-connect additional portions of the delta to the surrounding water bodies and restore hydrologic processes.

Establishing native wetland vegetation is an integral component of the project's restoration goals. Hydrologic processes, including water depth and duration of flooding, are important factors driving the composition and distribution of wetland plant communities (Kadlec and Knight 1996, Hammer 1997). Methods for tracking vegetation response to changes in the hydrologic regime consisted of mapping plant communities using remote sensing images and collecting plant species frequency and cover data in field monitoring plots. Remote sensing images were obtained in 1998 and 2000, and results from these efforts are summarized in Hak (2004) and Elseroad et al. (2004a). This report summarizes results from data collected in vegetation monitoring plots between 2000 and 2004, with the objective of evaluating the short-term responses of wetland plants to the restoration of hydrologic processes.

2. Methods

2.1 Site Description

The Williamson River Delta Preserve is located in Klamath County, Oregon along the lower stretch of the Williamson River where it drains to Upper Klamath Lake (Figure 1). The preserve totals approximately 7,400 acres in size and is composed of three separate parcels: Tulana, Goose Bay, and South Marsh (Figure 1). Tulana was farmed between the 1940's and 1997 and is being restored to wetland and upland vegetation with the exception of two fields that remain in agricultural production (Figure 1). In the future, the westernmost agricultural parcel on Tulana will also be restored to wetland vegetation. The Goose Bay portion has been farmed since the 1940's and continues to be utilized for agricultural production. All of Goose Bay will be restored to wetland and upland vegetation in the future except for one field that will remain in agricultural production. South Marsh was used for cattle grazing prior to purchase by the Nature Conservancy in 1999 and currently is being restored to wetland and upland vegetation.

2.11 Vegetation

Vegetation at the Williamson River Delta Preserve fall into two main categories: 1) plant communities that colonized the former agricultural fields upon abandonment, drainage canals, and levees; and 2) cultivated crops that were planted on the remaining agricultural parcels. Vegetation that has naturally colonized the preserve can be grouped into the following broad plant community types: upland, transitional, and emergent wetland (Figure 2). Hydrology drives the distribution of vegetation and reflects transitions occurring from upland to wetland with increasing water depth and duration of flooding.

In addition, isolated transplantings of wetland vegetation occurred during the construction phase of the Campfields and Riverbend early action projects (Graham Matthews and Associates 2001). *Scirpus acutus* was transplanted at Campfields on a fill bench, and at Riverbend, *Salix* sp., *Scirpus acutus*, and *Typha latifolia* were transplanted close to the river although the extent and exact location of the plantings were not recorded.

2.12 Water management

The Tulana portion of the preserve is divided into six separate water management units (Fields 2-5, Fields 6-7, E-1 and Strip, North Pump and Seachlight, Riverbend, and Campfields; Figure 2) that are separated by internal levees. Fields within each of these units are hydrologically connected, and thus hydrologic regimes at a given elevation in these units are the same. Since 1998, water management at Fields 2-5, Fields 6-7, E-1, Strip, North Pump, and Seachlight, has consisted of pumping water off the remaining agricultural parcels in the spring and transferring it to these wetland fields, where it slowly evaporates and seeps into the lake during the growing season.

Water from the Williamson River was pumped onto Campfields and Riverbend from 1998-2000. In the fall of 2000, Campfields and Riverbend were hydrologically reconnected to Agency Lake and the Williamson River, respectively by breaching sections of the levee. These parcels are subjected to lake and river level fluctuations as a result. Water was never pumped onto South Marsh. Prior to purchase by The Nature Conservancy in 1999, water at South Marsh that seeped through the external levee from Upper Klamath Lake was pumped off to allow cattle grazing. This practice was discontinued in 1999, and seepage provided some seasonal flooding at South Marsh from 1999-2003. In the fall of 2003, South Marsh was reconnected hydrologically to Upper Klamath Lake by breaching sections of the levee.

The hydrologic regime associated with each water management unit is summarized in Table 1. Data are not provided for 2001 because staff gauges were not surveyed that year. Staff gauges were installed in 1999 in the Upper Fields, in 2002 in Riverbend, and in 2003 in South Marsh, thus data are not available for these fields in previous years. Hydrologic regimes were calculated using staff gauge data and one-foot resolution ground surface elevations obtained from a digital elevation model (DEM) created for the preserve. Ground surface elevations on the preserve gradually slope from east to west and range from 4130-4150 feet.

2.2 Vegetation monitoring plots

A total of 387 3 x 3 meter permanent vegetation monitoring plots were established along elevational gradients at the Williamson River Delta Preserve (Figure 2). In 2000, 302 of the 387 plots were established across Tulana in the following fields: Fields 2-5, Fields 6-7, E-1, Strip, North Pump, Seachlight, and Campfields. An additional plot (F5 20) was originally established in 2000, but this plot was never sampled. The remaining 85 plots were established in 2002 at Riverbend and South Marsh. Plots are located primarily in areas that experience seasonal flooding, although a few plots in each field are located in upland plant communities. At the time of establishment, all plots were marked with rebar and PVC pipe, and plot locations were recorded with a Garmin GPS unit. In 2003, all PVC pipes were labeled with a metal tag, and plot locations were re-surveyed using a CMT GPS unit. The PVC pipes serve as the corner of the plot. Plots are oriented ahead of and to the right as one faces the next plot in the transect that has a higher plot number.

In 2000 and 2001, nested frequency sampling was used to monitor plant species frequency at all 302 plots established in 2000. Nested frequency plots consisted of four nested quadrats of the following sizes: $0.01m^2$, $0.1m^2$, $1.0m^2$, and $3m^2$. A nested quadrat sampling frame consisting of the three smallest quadrats was placed with the smallest quadrat's corner against the plot pole, inside the $3m^2$ quadrat. Each species was recorded only in the smallest plot size in which it was found. Data were collected by Paul McCormick (Williamson River Delta Preserve Director) and Andrea Rabe (private contractor) between September 4th and September 15th in 2000. In 2001, data were collected by Chad Ferguson (Williamson River Delta Preserve Aquatic Ecologist) and Andrea Rabe between August 8th and August 31st.

In 2002, vegetation sampling was conducted only at Campfields, Riverbend, and South Marsh (149 plots). Estimates of plant cover by species were made in the $3m^2$ quadrat size instead of nested frequency sampling. Data were collected by Chad Ferguson and Kathleen Jones (TNC field assistant) in late summer.

In 2003, vegetation sampling was conducted at all 387 vegetation monitoring plots. Plant cover by species was estimated in the $1m^2$ quadrats and frequency of additional species occurring in the $3m^2$ quadrats was recorded. Percent cover of all species greater than 1% was recorded to the nearest percentage. For species with cover less than 1%, cover classes of 0.5%, 0.25%, and 0.1% were used. The 0.1% cover class represented cover of 0.1% and below. Percent cover of the following substrates also was recorded: litter, water, and bare ground. Cardboard cutouts representing different amounts of percent cover were used to train observers and provide consistency in cover estimates. Plots in fields that experienced the earliest drawdowns (e.g. E-1, Strip, North Pump, and Seachlight) were sampled first, and areas with the deepest water were sampled last (e.g., Fields 2-5). Nomenclature followed Hitchcock and Cronquist's (1973) Flora of the Pacific Northwest. Representative specimens of unknown plant species were collected, identified using dichotomous keys, and a subset verified by wetland botanist John Christy of the Oregon Natural Heritage Program. Voucher specimens were mounted and added to the project's herbarium collection. All data were collected by Adrien Elseroad (Wetland Vegetation Ecologist) and Carla Stevens (Williamson River Delta Preserve Field Ecologist) between August 12th and October 1st.

In 2004, vegetation sampling was conducted only at Campfields, Riverbend, and South Marsh. The same methodology was used as in 2003. All data were collected by Adrien Elseroad and Carla Stevens between September 9th and September 13th. Adrien Elseroad keyed out all new plant species, and voucher species were mounted and added to the project's herbarium collection.

2.3 Data Analysis

Data were divided into the following units for analysis: Fields 2-5 (106 plots); Fields 6-7 (68 plots); Campfields (64 plots); the Upper fields (North Pump, Searchlight, E1, and Strip) (63 plots), Riverbend (45 plots), and South Marsh (40 plots). Fields within each of these six units experience similar water management regimes and are thus considered distinct hydrologic units.

Within each unit, frequency and cover by species as well as plant guild were calculated for each year data were collected. Plant guilds created for analysis included: native perennial wetland species (obligate wetland (OBL) and facultative wetland (FACW and FACW+), native annual wetland species (OBL, FACW, and FACW+), native non-wetland species (wetland status other than those listed above), and exotic species. Biennial species were treated as annuals for analysis. Species nativity, duration, and wetland status follow USDA (2004).

Frequency values refer to the percentage of plots with an occurrence of a given species or guild. Frequency values were calculated using The Nature Conservancy's Nested Frequency Data Management and Analysis Workbook (The Nature Conservancy 2000). The nested frequency quadrat sampling method used in 2000 and 2001 provided a range of quadrat sizes in which data can be compared in future years. For this method to be most effective, sampling data are presented for the quadrat size in which frequency values fall between 30% and 70%, allowing sensitivity to upward or downward change (Elzinga et al. 1998). In the years this sampling method was used, frequency values were between 30% and 70% for most species in the largest quadrat size ($3m^2$). Therefore frequency values noted in the Results section of this report are only from the $3m^2$ quadrats. These data allow comparisons between 2000 and 2001 data as well as 2002, 2003, and 2004 (from the $3m^2$ quadrats). Frequency data from $1m^2$ quadrats for 2003 and 2004 are also shown in the tables provided at the end of this report for comparison with cover data collected in the same size quadrats.

McNemar tests (SYSTAT 2004) were performed to test for differences in plant guild frequencies in the $3m^2$ quadrats between sampling years within each water management unit with p-values set at 0.05. Binomial confidence intervals were also calculated for plant species and guild frequencies using The Nature Conservancy's Binomial Confidence Intervals workbook (The Nature Conservancy 1999) with confidence levels set at 95%.

Average percent cover by species and guild were calculated for data collected in 2003 and 2004. Average percent cover for each hydrologic unit was calculated by summing the total cover of each species or plant guild and dividing the value by the total number of plots in that unit. Although cover data were collected in 2002, it was later determined that the $3m^2$ plots were too large to estimate cover accurately, thus cover data from 2002 were not used for this analysis.

Cover data were not collected in 2000 or 2001. For the Campfields, Riverbend, and South Marsh sites, a single factor analysis of variance (ANOVA) (Microsoft Excel 2002) was used to test for differences in the average cover of each plant guild between 2003 and 2004, with p-values set at 0.05.

3. Results

The data analyzed in this report were collected by several different observers over several years, and there were inconsistencies among years. One such inconsistency was with species identification. Eight species found in monitoring plots between 2000 and 2002 were not identified correctly. Voucher specimens for those species were not collected and therefore misidentification cannot be verified with certainty, but those species were likely misidentified because each of these species was recorded as occurring in plots in one of the years between 2000 and 2002, but was not recorded again in following years. In following years, in those same plots, species within the same genus were found and positively identified. Also, the species that were misidentified are not listed as occurring at other wetland restoration projects in the Upper Klamath Basin (BLM 2003, MacLaren and Geiger 2001). Therefore, those species names were changed so that comparisons could be made with data collected in 2003 and 2004. Species name changes include: *Gnaphalium canescens* changed to *G. palustre*, *Sonchus arvensis* changed to *S. asper*, *Typha angustifolia* changed to *T. latifolia*, *Hordeum vulgare* changed to *H. jubatum*, *Aster chilensis* changed to *Symphyotrichum* (formerly *Aster*) *frondosum*, *Eleocharis ovata* changed to *E. palustris*, *Potentilla glandulosa* changed to *P. anserina*, and *Salix breweri* changed to *S. lucida* ssp. *lasiandra*.

3.1 Species richness 2000-2004

One hundred eighteen species were identified in vegetation plots between 2000 and 2004 (Table 2): 82 species are considered native, 32 exotic, and 4 of unknown origin. Thirty-seven of the native species are perennial wetland species, 15 are annual wetland species, and 30 are non-wetland species. Exotic species were primarily annual and biennial upland species although 6 exotic wetland species were found. Twenty-four species were identified on other parts of the preserve in addition to the species found in monitoring plots. Species richness by water management unit is provided in Table 3. In general, species richness increased within each water management unit over time.

3.2 Hydrology and vegetation within each water management unit

3.21 Fields 2-5

Hydrologic regime 2000-2003

Water was pumped off the agricultural parcels and on to Fields 2-5 in the spring of each year. In 2000 and 2002, maximum water depths in flooded areas ranged from 0.7-3.7 ft., and drawdown occurred between May and September (Table 1). In 2003, maximum water depths were 0.4 feet lower than in 2000. However, drawdown did not occur between 4132 and 4134 ft., and at 4135 ft., drawdown occurred two months later than in 2002 (July vs. May).

Frequency in 3m^2 plots 2000-2003

Native perennial wetland plant guild frequencies significantly decreased from 2000 to 2001 (50% and 34%, respectively) but significantly increased in 2003 (59%) ($p<0.05$) (Figure 3). Shifts in native perennial wetland species composition and frequency also were apparent (Figure 4, Table 4). In 2000 and 2001, *Eleocharis acicularis*, *Typha latifolia*, and *Scirpus acutus* were the most frequently occurring native perennial wetland species. Between 2000 and 2003, *Eleocharis acicularis* and *Typha latifolia* frequencies declined and *Scirpus acutus* frequencies increased. *Hippuris vulgaris* frequencies also increased in 2003, from 4% in 2001 to 46% in 2003. *Eleocharis palustris*, which did not occur in plots in 2000 or 2001, occurred in 25% of plots in 2003. Three other native perennial wetland species not previously recorded in plots were found in 2003: *Elodea canadensis*, *Polygonum amphibium*, and *Scirpus maritimus*, although frequencies of each of these species were less than 10%.

Native annual wetland, native non-wetland, and exotic plant guild frequencies significantly declined between 2000 and 2003 ($p<0.05$) (Figure 3). Native annual wetland plant guild frequencies declined from 93% in 2000 to 51% in 2001 and 8% in 2003. Declines were largely due to decreased frequencies of *Rumex maritimus* and *Bidens cernua* (Table 4). Native non-wetland plant guild frequencies declined from 73% in 2000 to 10% in 2001 and 1% in 2003. This was largely due to decreased *Panicum capillare* frequencies (Table 4). Exotic plant guild frequencies declined from 100% in 2000 to 28% in 2001 and 11% in 2003 due to decreased frequencies of *Polygonum persicaria*, *Elytrigia repens*, *Chenopodium album*, and *Sisymbrium altissimum* (Figure 5). Exotic and non-wetland native species richness also declined between 2000 and 2003 (Table 3).

Shifts in species composition and frequencies between 2000 and 2003 reflect changes in water management that occurred during the same time. Areas that had experienced drawdown by August 2000 were flooded up to 1.3 feet in August 2003 (Table 1). Deeper water and lack of drawdown in 2003 prevented germination and high frequencies of annual native (e.g. *Rumex maritimus* and *Bidens cernua*) and exotic species (e.g. *Chenopodium album* and *Polygonum persicaria*) as occurred in 2000. These conditions also favored the native perennial wetland species *Hippuris vulgaris*, which spreads by rhizomes and tolerates water depths up to 6 feet (Hamel and Parsons 2001).

Cover in 1m^2 plots 2003

Plot coverage in 2003 was dominated by water, which averaged 66% cover. Plant cover averaged 34% (Table 4) and was composed largely of native perennial wetland species (Figure A1), which averaged 30% cover. The native perennial wetland species *Hippuris vulgaris* was the dominant species in 1m^2 plots, averaging 17% cover.

3.22 Fields 6-7

Hydrologic regime 2000-2003

Water was pumped off the agricultural parcels and on to Fields 6-7 in the spring of each year. In 2000, maximum water depths in flooded areas ranged from 0.5-5.5 ft., and drawdown occurred at 4135 and 4136 ft. between August and October (Table 1). In 2002, water depths were substantially lower, and drawdown occurred earlier than in 2000. Maximum water depths declined by 2.3 ft., and drawdown occurred between May and August. In 2003, maximum water depths increased by 0.3 ft. from 2002 but were still 2 ft. lower than in 2000. Drawdown occurred in July at 4135 ft. (compared to October in 2000 and May in 2002).

Frequency in $3m^2$ plots 2000-2003

Native perennial wetland plant guild frequencies significantly declined from 50% in 2000 to 31% in 2001 but significantly increased to 43% in 2003 ($p<0.05$) (Figure 6). Changes in native perennial wetland plant guild frequencies were due to declines in *Juncus balticus* and increases in *Lemna minor* (Figure 7). *Juncus balticus* frequencies were 21% in 2000 but did not occur in plots in either 2001 or 2003. Frequencies of *Lemna minor* increased from 1% in 2000 to 19% in 2003. *Scirpus acutus* was the dominant native perennial wetland species in all three years, with frequencies ranging from 28-32% (Figure 7, Table 5). In 2003, five native perennial wetland species not previously recorded in plots were found: *Eleocharis palustris*, *Polygonum amphibium*, *Potamogeton pectinatus*, *Agrostis exarata* and *Carex angustata*, although frequencies of each of these species were less than 5%.

Native annual wetland plant guild frequencies were not significantly different between years (Figure 6). Frequencies ranged from 16% to 26% between 2000 and 2003 with no clear pattern over time. *Bidens cernua* and *Rumex maritimus* were the dominant native annual wetland species in all three years (Table 5).

Native non-wetland plant guild frequencies significantly increased from 10% in 2000 to 40% in 2001, although frequencies significantly declined to 22% in 2003 ($p<0.05$) (Figure 6). Declines were largely due to decreased frequencies of *Panicum capillare*, *Poa secunda*, and *Gnaphalium palustre* (Table 5).

Exotic plant guild frequencies significantly increased from 13% in 2000 to 51% in 2001 but significantly declined to 31% in 2003 ($p<0.05$) (Figure 6). Changes in *Polygonum persicaria*, *Chenopodium album*, and *Cirsium vulgare* frequencies largely drove the increases and subsequent declines in exotic guild frequencies (Figure 8). The exotic grass *Phalaris arundinacea*, which did not occur in plots in previous years, was present in 15% of plots in 2003.

Changes in species frequencies between 2000 and 2003 can be attributed to changes in water management. Portions of Fields 6-7 that had water depths up to 1.5 feet and drawdowns occurring in October in 2000 were completely dry by July in 2003 (Table 1). The earlier drawdowns and shallower water depths in 2003 favored both native non-wetland (e.g. *Panicum capillare* and *Gnaphalium palustre*) and exotic non-wetland (e.g. *Chenopodium album* and

Cirsium vulgare) species over wetland perennial and annual species. Water depth data were not available for 2001, but it is likely that water depths were lower and drawdowns earlier in 2001 compared to 2000 since native perennial wetland frequencies declined and native non-wetland, and exotic frequencies increased between 2000 and 2001.

Cover in $1m^2$ plots 2003

Plots in 2003 were dominated equally by water and plants, both averaging 45% cover (Table 5). Plant species cover was composed largely of native perennial wetland species, which averaged 21% cover, and exotic species, which averaged 17% cover. *Scirpus acutus* was the dominant species in $1m^2$ plots, averaging 15% cover.

3.23 Upper Fields

Hydrologic regime 2000-2003

Water management in the Upper Fields consisted of pumping water from the agricultural parcels to these wetland fields in the spring of each year. Maximum water depths in flooded areas ranged from 0.2-4.2 ft in 2000 (Table 1). Flooding occurred year-round at 4137 ft., and between 4138 and 4141 ft., drawdown occurred between July and December. In 2002, maximum water depths increased by 0.8 ft., but drawdown occurred earlier than in 2000. In 2003, maximum water depths only declined by 0.1 ft. from 2002, but drawdowns occurred between one and five months earlier than in 2002.

Frequency in $3m^2$ plots 2000-2003

Native perennial wetland plant guild frequencies significantly declined from 65% in 2000 to 29% in 2001, but significantly increased to 62% in 2003 ($p<0.05$) (Figure 9). Declines between 2000 and 2001 were largely due to decreased frequencies of *Scirpus acutus*, *Veronica anagallis-aquatica*, and *Typha latifolia* (Figure 10). *Scirpus acutus* was the dominant native perennial wetland species in all three years, with frequencies ranging from 27-41%. In 2003, five native perennial wetland species not previously recorded in plots were found: *Eleocharis palustris*, *Agrostis exarata*, *Potentilla anserina*, *Scirpus maritimus*, and *Scirpus americanus*, although only *Eleocharis palustris* frequencies were greater than 10% (Table 6).

Native annual wetland plant guild frequencies also significantly declined between 2000 and 2001, from 32% to 8%, but frequencies significantly increased in 2003 to 73% ($p<0.05$) (Figure 9). Changes between 2000 and 2003 largely resulted from declines in *Rumex maritimus* frequencies from 30% in 2000 to 8% in 2001, and increases in 2003 to 71% (Table 6). Three native annual wetland species not previously recorded in plots were found in 2003: *Bidens frondosa*, *Rorippa curvisiliqua*, and *Polygonum lapathifolium*. The frequency of *Bidens frondosa* in 2003 was 17%, while the other native annual wetland species occurred in less than 10% of plots.

Native non-wetland plant guild frequencies significantly increased from 17% in 2000 to 38% in 2001 and 57% in 2003 ($p<0.05$) (Figure 9). The dominant native non-wetland species in

all three years was *Potentilla norvegica*. In 2003, five native non-wetland species not previously recorded in plots were found. *Epilobium ciliatum* ssp. *watsonii* and *Panicum capillare* were relatively common, each occurring in 20% of plots.

Exotic plant guild frequencies significantly increased between 2000 and 2003, from 65% to 89% ($p<0.05$) (Figure 9). Differences between 2000 and 2001 were not statistically significant. Increases between 2000 and 2003 were due largely to *Chenopodium album* frequencies increasing from 33% in 2000 to 78% in 2003 and *Polygonum persicaria* frequencies increasing from 11% in 2000 to 29% in 2003 (Figure 11). Other exotic species common among all three years included *Elytrigia repens* and *Lactuca serriola*.

Changes in species frequencies between 2000 and 2003 reflect changes in water management that occurred during the same time. Portions of the Upper Fields in 2000 that were flooded up to 3 feet with drawdown occurring in December were completely dry by July in 2003 (Table 1). The earlier drawdowns and shallower water depths in 2003 allowed both native (e.g. *Rumex maritimus* and *Panicum capillare*) and exotic (e.g. *Chenopodium album* and *Polygonum persicaria*) annual species to germinate and increase in frequency.

Cover in $1m^2$ plots 2003

Plant cover in $1m^2$ plots averaged 55% cover, and bare ground cover averaged 31% (Table 6). Plant cover was composed largely of exotic species (33%), and native annual species, which averaged 11%. *Chenopodium album* and *Rumex maritimus* were the dominant species in $1m^2$ plots, averaging 19% and 11% cover, respectively.

3.24 Campfields

Hydrologic regime 2000-2004

Until the fall of 2000, water management at Campfields consisted of pumping water off agricultural parcels in the spring and transferring it to these wetland fields. Levees were breached at Campfields in the fall of 2000; thus the hydrologic regime has been driven by lake level fluctuations since then. In 2000, maximum water depths in flooded areas ranged from 0.5-4.5 ft., and drawdown occurred between June and October (Table 1). In 2002, maximum water depths increased by 0.5 ft., and drawdown occurred during the same month or one month later than in 2000. In 2003, maximum water depths increased by 0.3 ft. and drawdown occurred during the same month or one month later than in 2002. In 2004, maximum water depths declined by 0.5 ft. from 2003, and drawdown occurred during the same month or one month earlier than in 2003.

Frequency in $3m^2$ plots 2000-2004

Native perennial wetland plant guild frequencies were not significantly different between 2000 and 2001 (80% and 78%, respectively), but a significant decline occurred in 2002 (53%) followed by a significant increase to 92% in 2003 ($p<0.05$) (Figure 12). Differences between 2003 and 2004 were not statistically significant. Changes in frequency largely resulted from decreased and subsequent increased frequencies of *Salix lucida* ssp. *lasiandra* and *Potamogeton pectinatus* between 2001 and 2003 (Figure 13). Common native perennial wetland species in all

five years were *Salix lucida ssp. lasiandra*, *Scirpus acutus*, and *Typha latifolia*. Two species, *Polygonum amphibium* and *Eleocharis palustris*, were not found in plots between 2000 and 2001 but occurred in 22% and 39% of plots, respectively, in 2004. Between 2003 and 2004, seven native perennial wetland species not previously recorded were found in plots (including three *Carex* species) although frequencies of each of these species were less than 11% (Table 7).

Native annual wetland plant guild frequencies significantly declined from 59% in 2000 to 36% in 2001, and significantly increased from 33% in 2002 to 58% in 2003 ($p<0.05$)(Figure 12). Differences between 2001 and 2002 as well as between 2003 and 2004 were not statistically significant. Individual species frequencies were also variable between years (Table 7). *Rumex maritimus* frequencies declined from a high of 48% in 2000 to 0% in 2002 but increased to 19% in 2003 and 23% in 2004. *Bidens frondosa* was not found in plots between 2000 and 2002 but occurred in 41% of plots in 2003 and 19% of plots in 2004. *Bidens cernua* was common between 2000 and 2003 with frequencies ranging from 22% to 31% but did not occur in plots in 2004. *Rorippa curvisiliqua* frequencies increased from 2% in 2002 to 31% in 2004. Between 2003 and 2004, seven native annual wetland species not previously recorded in plots were found, although frequencies of each of these species were less than 12% with the exception of *Bidens frondosa* (Table 7).

Native non-wetland plant guild frequencies significantly declined from 44% in 2000 to 28% in 2001 ($p<0.05$) but differences in following years were not statistically significant (Figure 12). Common native non-wetland species included *Panicum capillare*, *Mentha arvensis*, *Amaranthus powellii*, and *Urtica dioica*. Between 2003 and 2004, five native non-wetland species not previously recorded in plots were found, although frequencies of each of these species were less than 7% (Table 7).

Exotic plant guild frequencies were not significantly different between 2000 and 2003 although frequencies significantly increased from 59% in 2003 to 80% in 2004 ($p<0.05$) (Figure 12). Increases in 2004 were largely driven by *Chenopodium album* which occurred in 64% of plots in 2004. Other common exotic species in all five years included *Elytrigia repens* and *Polygonum persicaria* (Figure 14). *Solanum dulcamara*, which did not occur in plots between 2000 and 2002, was found in 14% and 17% of plots in 2003 and 2004, respectively. Four exotic species not previously recorded in plots were found in 2004 although frequencies of these species were less than 6% with the exception of *Solanum dulcamara* (Table 7).

It is unclear whether changes in the hydrologic regime were related to changes in species frequencies between 2000 and 2003. Water depths increased slightly each year between 2000 and 2003 (Table 1). This normally benefits perennial wetland species rather than annual and non-wetland species. However, changes in frequencies did not follow this trend. Native perennial wetland guild frequencies declined between 2001 and 2002 then increased in 2003. Native annual wetland frequencies also increased between 2002 and 2003. It is possible that some of these trends are due to observer bias. For example, in 2002, *Potamogeton pectinatus* was not found in any plots even though it occurred in plots every other year. This submerged macrophyte normally occurs in standing water, and it is not visible unless it is scooped out of the water. Changes in frequencies appear to be related to changes in the hydrologic regime between 2003 and 2004. In 2004, on portions of Campfields, water depths were approximately 0.5 feet lower

and drawdown occurred earlier than in 2003. These drier conditions were associated with an increase in frequency and cover of *Chenopodium album*, (an exotic annual) and a decline in frequency and cover of *Potamogeton pectinatus*.

Cover in 1m^2 plots 2003-2004

Plant cover averaged 67% in 2003 and 77% in 2004 (Table 7). Plant cover was composed largely of native perennial wetland species (averaging 44% cover in 2003 and 50% in 2004). Differences in average cover between 2003 and 2004 were not statistically significant for native perennial wetland, native annual wetland, and native non-wetland plant guilds. However, average cover of exotic species significantly increased from 10% in 2003 to 19% in 2004 ($p<0.05$). *Chenopodium album* was the exotic species with the highest average cover in both 2003 (3%) and 2004 (9%).

Potamogeton pectinatus was the species with the highest average cover (15%) in 2003 although cover declined to 6% in 2004. This aquatic species was not widespread and only occurred in areas with standing water. However, where it did occur, it often covered 100% of the plot. In 2004, *Scirpus acutus* and *Salix lucida* ssp. *lasiandra* had the highest cover, each averaging 12%.

3.25 Riverbend

Hydrologic regime 2002-2004

River level fluctuations have driven the hydrologic regime at Riverbend since levees were breached in the fall of 2000. In 2002, maximum water depths in flooded areas ranged from 0.1-5.1 ft., and drawdown occurred between May and September (Table 1). Maximum water depths were higher in 2003 by 0.3 ft., and drawdown occurred during the same month or one month later than in 2002. Maximum water depths declined by 0.6 ft. in 2004, and drawdown occurred one month earlier than in 2003.

Frequency in 3m^2 plots 2002-2004

Native perennial wetland plant guild frequencies significantly increased from 58% in 2002 to 96% in 2003 ($p<0.05$) (Figure 15). Differences between 2003 and 2004 were not statistically significant. Dominant native perennial wetland species in all three years included *Eleocharis palustris, Eleocharis acicularis, Alisma plantago-aquatica*, *Salix geyeriana*, and *Sagittaria cuneata*. Frequencies for all of these species increased from 2002 to 2003 (Figure 16), while frequencies of three species—*Eleocharis acicularis, Alisma plantago-aquatica,* and *Sagittaria cuneata*—increased again between 2003 and 2004. *Salix lucida* ssp. *lasiandra* only occurred in 4% of plots in 2002 and increased to 40% in 2003 and 2004. Another common species in 2003 and 2004 was *Alopecurus aequalis*. This species was not found in plots in 2002 but occurred in 58% of plots in 2004. In 2004, *Azolla mexicana* was found in plots for the first time and occurred in 22% of plots. Between 2003 and 2004, an additional 17 native perennial wetland species not previously recorded in plots were found. Frequencies of each of these species were less than 18% (Table 8) with the exception of *Alopecurus aequalis.*

Native annual wetland plant guild frequencies significantly increased from 44% in 2002 to 76% in 2003 ($p<0.05$) (Figure 15). Differences between 2003 and 2004 were not statistically significant. Dominant native annual wetland species in 2003 and 2004 included *Bidens cernua, Rumex maritimus, Cyperus aristatus,* and *Symphyotrichum frondosum* (Table 8). Seven additional native annual wetland species not previously recorded in plots were found between 2003 and 2004.

Native non-wetland plant guild frequencies comprised 60% of plots in both 2002 and 2003 and significantly increased to 78% in 2004 ($p<0.05$) (Figure 15). *Gnaphalium palustre* and *Panicum capillare* were the most frequently occurring native non-wetland species in all three years. Twelve native non-wetland species were found in 2004 that were not previously recorded. Frequencies for each of these species were less than 11% (Table 8).

Exotic plant guild frequencies were not significantly different between 2002 (80%), 2003 (82%), and 2004 (80%; $p<0.05$; Figure 15). However, individual species frequencies did vary between years (Figure 17). *Phalaris arundinacea* and *Polygonum aviculare* frequencies increased between 2002 and 2003, but in 2004, *Phalaris arundinacea* increased while *Polygonum aviculare* decreased in frequency. *Echinochloa crus-galli* and *Chenopodium album* decreased between 2002 and 2003. *Echinochloa crus-galli* decreased again in 2004 while *Chenopodium album* increased. *Cirsium vulgare* was not found in 2002, but was present in 2003 (at 7%) and increased to 13% in 2004. An additional twelve exotic species not previously recorded in plots were found between 2003 and 2004. Frequencies of each of these species were less than 11% with the exception of *Cirsium vulgare* (Table 8).

Some changes in species frequencies between 2003 and 2004 reflect changes in the hydrologic regime. Water depths on portions of Riverbend were 0.6 feet lower in 2004, and drawdown occurred a few weeks earlier than in 2003. This was associated with increased native non-wetland plant guild frequencies and increased frequencies of some annual species including the exotic *Chenopodium album*. Changes in hydrology did not adversely affect the native perennial wetland species as most continued to increase in frequency and cover between 2003 and 2004.

Cover in $1m^2$ plots 2003-2004

Plants were the dominant cover type in 2003 and 2004. Plant cover averaged 64% in 2003 and 81% in 2004 (Table 8) and was composed largely of native perennial wetland species, which averaged 44% cover in 2003 and increased significantly to 61% in 2004 ($p<0.05$). Differences in average cover between 2003 and 2004 were not statistically significant for the other plant guilds.

Species with the greatest cover in 2003 and 2004 included *Eleocharis acicularis*, which averaged 10% in 2003 and 20% in 2004, and *Eleocharis palustris*, which averaged 10% in 2003 and 5% in 2004.

3.26 South Marsh

Hydrologic regime 2003-2004

South Marsh was flooded by seepage through the external levee from 2002 and 2003. Levees were breached in the fall of 2003, and thus the hydrologic regime in 2004 was driven by lake levels. In 2003, maximum water depths in flooded areas ranged from 0.9-2.9 ft. (Table 1). At 4140 ft., drawdown occurred in July. Drawdowns in areas below 4140 ft. could not be calculated because the staff gauge is located at 4140 ft. In 2004, water depths increased by approximately 2 ft. and drawdown occurred one month later than in 2003. Drawdown did not occur between 4138 and 4139 ft., but between 4140 and 4142 ft., drawdown occurred from June through August.

Frequency in $3m^2$ plots 2002-2004

Native perennial wetland plant guild frequencies significantly increased from 53% in 2002 to 73% in 2003 ($p<0.05$), but differences between 2003 and 2004 were not statistically significant (Figure 18). Native perennial wetland species frequencies were variable between years. *Eleocharis palustris* was the dominant species in all three years, occurring in 58% of plots by 2004. *Potentilla anserina*, *Distichlis stricta*, and *Juncus balticus* increased in frequency between 2002 and 2003, but frequencies either did not change or declined by 2004 (Figure 19, Table 9). In 2004, *Lemna minor* increased from 3% in 2003 to 23%, and *Potomogeton pectinatus*, which was not previously found in plots, occurred in 23% of plots. In addition to *Distichlis stricta*, *Potomogeton pectinatus*, and *Lemna minor*, another seven native perennial wetland species not previously recorded in plots were found between 2003 and 2004, although frequencies were less than 10%.

Native annual wetland plant guild frequencies significantly increased from 18% in 2002 to 43% in 2003 but significantly declined to 23% in 2004 ($p<0.05$) (Figure 18). *Symphyotrichum frondosum* and *Rumex maritimus* were the most frequently occurring native annual wetland species in 2003 and 2004 (Table 9). An additional six native annual wetland species not previously recorded in plots were found between 2003 and 2004, although with the exception of *Rumex maritimus*, frequencies of each of these species were less than 8%.

Native non-wetland plant guild frequencies were not significantly different between 2002 and 2003 (23% and 20%, respectively), but frequencies significantly declined to 8% in 2004 ($p<0.05$) (Table 9). *Hordeum jubatum* was a common native non-wetland species in 2002 and 2003, but was not found in plots in 2004. An additional five native non-wetland species not previously recorded in plots were found between 2003 and 2004, although frequencies of each of these species were less than 3%.

Exotic plant guild frequencies significantly increased from 50% in 2002 to 90% in 2003, but significantly declined to 48% in 2004 ($p<0.05$) (Figure 18). Changes in frequency were largely driven by *Chenopodium album*, which increased in frequency from 38% in 2002 to 83% in 2003, but declined to 43% in 2004. Other common exotic species included *Phalaris arundinacea* and *Elytrigia repens* (Figure 20). An additional seven exotic species not previously recorded in plots were found between 2003 and 2004, although frequencies of these species were less than 8% (Table 9).

Changes in species frequencies between 2002 and 2004 reflect changes in hydrology that occurred during the same time. The levee breaches in the fall of 2003 resulted in water depths on portions of South Marsh that were 2 feet deeper, with drawdown occurring about one month later in 2004 as compared to 2003 (Table 1). Increased water depths in 2004 favored native perennial wetland species tolerant of deeper water (e.g., *Lemna minor* and *Potomogeton pectinatus*) over annual natives and exotics (e.g., *Chenopodium album*).

Cover in $1m^2$ plots 2003-2004

The cover of $1m^2$ plots in 2003 was dominated by plants and bare ground, which averaged 51% and 46% cover, respectively (Table 9). However, in 2004, plant cover and bare ground declined to 30% and 26%, respectively, while the cover of water increased from 3% in 2003 to 33% in 2004. Plant cover was composed largely of native perennial wetland species in both 2003 and 2004, which averaged 31% in 2003 and 21% in 2004. Differences in average cover between 2003 and 2004 were not statistically significant for any of the plant guilds. *Eleocharis palustris* had the highest average cover in both years, averaging 21% in 2003 and 15% in 2004.

4. Discussion

4.1 Native wetland plant community development

Seven years after hydrologic restoration, native wetland plant species dominate large portions of the Williamson River Delta Preserve that are not used for agricultural production. In 2003, native perennial wetland species occurred in 71% of all $3m^2$ vegetation monitoring plots and comprised 56% of the total plant cover in $1m^2$ plots. Native annual wetland species occurred in 46% of all $3m^2$ vegetation monitoring plots and comprised 11% of the total plant cover in $1m^2$ plots. Additional native wetland plant species continue to colonize vegetation monitoring plots as well. Between 2003 and 2004, an additional eleven native perennial and eight native annual wetland species were found in plots.

Changes in wetland species composition and frequency over the sampling period in some wetland fields followed predicable patterns that often occur in restored wetlands. Rapid colonization by a few species is common following the restoration of the hydrologic regime, while less common or dispersal-limited species are slower to colonize (Zedler 2000, Galatowitsch and van der Valk 1996). In Fields 2-5, 6-7, the Upper Fields, and Campfields, water management was initiated in 1998. Although native wetland species colonized these fields relatively quickly, frequencies in 2000 were dominated by only a few species including *Scirpus acutus* and *Typha latifolia* (and *Salix lucida* ssp. *lasiandra* in Campfields). By 2003, additional native wetland species colonized the fields, and individual species that were uncommon initially, such as *Eleocharis palustris*, *Polygonum amphibium*, and *Hippuris vulgaris*, increased in frequency.

4.2 Effects of hydrologic reconnection

Campfields and Riverbend were hydrologically reconnected to Agency Lake and the Williamson River, respectively, in the fall of 2000. By 2003, native perennial wetland species frequency, cover, and richness were greatest at these two sites as compared to the other sites that were not reconnected and only experienced managed flooding. Native perennial wetland species occurred in 92% and 96% of plots at Campfields and Riverbend, respectively, and averaged 44% cover. In contrast, native perennial wetland species frequencies were 43%-73% and averaged 8%-31% cover at the other wetland fields. A total of 19 and 24 native perennial wetland species were found at Campfields and Riverbend, respectively, compared to 8-11 species at the other wetland fields. Native annual species richness was also higher at Campfields and Riverbend in 2003, where a total of 8 and 10 species were found, respectively, compared to 3-6 species at the other wetland fields.

Although the differences between reconnected sites versus sites with managed flooding cannot conclusively be attributed to hydrologic reconnection, it is likely that reconnection enhanced wetland plant community development. Increased quantities and diversity of wetland plant propagules dispersed by water, combined with the hydrologic regimes associated with the reconnected sites, probably contribute to increased establishment and persistence of native wetland species. Compared to Campfields and Riverbend, hydroperiods and drawdowns associated with unconnected wetland fields experienced much more year-to-year variability. This variability may prevent new species from becoming established and existing species from increasing in cover and frequency. For example, high year-to-year variability and early drawdown in 2003 seemed to favor native and exotic annual species over perennial wetland species in the Upper Fields.

In addition to water depth and hydroperiod, which are primary factors driving the distribution of wetland vegetation (Hammer 1997), other factors appear to influence species composition at the Williamson River Delta. Wetland plant species richness and frequency at Riverbend exceeded that in Campfields in 2003 and 2004 even though these fields experienced similar hydrologic regimes and were reconnected at the same time. Several factors distinguish Riverbend from Campfields and the other wetland fields including landscape position, ground surface elevations, microtopographic variation, and soil type.

The location of Riverbend along the Williamson River may provide a more consistent and diverse supply of wetland plant propagules compared to Campfields' location along Agency Lake. Conditions for species establishment may also be more favorable at Riverbend where most vegetation monitoring plots are located between 4141 and 4143 feet, compared to 4139-4142 feet at Campfields. Plots at Riverbend encompass the range of elevations that could support riparian/wet prairie plant communities as well as the upper end of the emergent plant community elevational range (Elseroad 2004). A greater number of species may tolerate shallower water depths and fairly short flooding durations at these elevations compared to areas with deeper water and longer flooding durations. Many wetland plants also grow more vigorously at the shallower end of their water tolerance range (Hammer 1997).

Microtopographic variation may be greater at Riverbend than Campfields. Small pools and channels created during earth moving operations associated with levee breaching increased the range of available habitats within small spatial scales, which could result in increased plant

diversity. The soil type at the two sites are also different, at Riverbend soils are Tulana silt loams, compared to Laki fine sandy loams at Campfields although it is unclear how these soil types affect plant community development.

Plant species establishment at Campfields and Riverbend may also be influenced by vegetation present prior to levee breaching. Although both sites were flooded with water from the Williamson River prior to levee breaching (from 1998 to 2000), vegetation at Campfields was already well established by 2000. In the years following levee breaching, species composition and distribution have not changed considerably at Campfields although new species have continued to establish. The initial response of a few dominant species (primarily *Salix lucida* ssp. *lasiandra* and *Scirpus acutus*) to managed flooding may prevent other species from expanding even if reconnection provides a greater diversity of wetland propagules. At Riverbend, the establishment of wetland vegetation prior to levee breaching was minimal (Mark Stern, personal communication). When the levees were breached, the availability of bare ground may have allowed a greater number of species to colonize and establish.

South Marsh was hydrologically reconnected to Upper Klamath Lake in the fall of 2003. Within one year following hydrologic reconnection, deeper water was associated with increases in submerged and floating aquatic species frequencies and cover. Given the trends at Campfields and Riverbend, it is likely that wetland species frequencies and richness will continue to increase at South Marsh for the next few years. The flow of water through the breached levees should increase the delivery of water-born wetland propagules.

However, species composition is likely to remain different at South Marsh as compared to Campfields and Riverbend, and species richness is expected to remain lower. Ground surface elevations across much of South Marsh (4138-4139 feet) are lower than Campfields and Riverbend. Fewer wetland species can tolerate the deeper water at those elevations although submerged and floating aquatic species will likely continue to expand. The few emergent species that tolerate deeper conditions will probably take longer to establish than if water depths were lower. In the shallower portions of South Marsh, cattle grazing may limit the development of plant communities. In 2003 and 2004, escaped cattle (belonging to an adjacent property owner) were observed at South Marsh during vegetation sampling and had grazed substantial amounts of wetland vegetation. The extent of grazing impacts on these communities in prior years is unclear.

4.3 Exotic species

Exotic species are a major component of the vegetation at the Williamson River Delta Preserve. In 2003, exotic species occurred in 59% of the $3m^2$ vegetation monitoring plots and comprised 27% of the total plant cover in $1m^2$ plots. The most frequently occurring exotic species are annuals (i.e., *Chenopodium album* and *Polygonum persicaria*) that can rapidly germinate following drawdown. However, these exotic species are not distributed evenly within the wetland fields. High frequencies of exotic species occur primarily at higher elevations in the transitional zones between wetland and upland that experience short flooding durations and early season drawdowns. In contrast, few exotic species are found in emergent zones where flooding durations are longer and drawdowns occur late in the growing season.

Exotic species frequency and distribution also exhibited high year-to-year fluctuations in response to changes in the hydrologic regime. Exotic species frequencies generally increased in years when drawdown occurred earlier in the growing season and declined when drawdown occurred later or did not occur at all. This trend was most apparent in Fields 2-5. In these fields, exotic species frequencies declined from 100% in 2000 to 11% in 2003. Drawdown in 2000 occurred between May and September and did not occur at all in most plots in 2003. Also, between 2003 and 2004, exotic species frequencies declined at South Marsh from 90% to 48% (largely driven by declines in *Chenopodium album*) as a result of deeper water associated with hydrologic reconnection to Upper Klamath Lake. These trends support research conducted by Paul McCormick at the preserve, which concluded that spring and early summer drawdowns favored exotic and native annual species (Aldous 2002).

Relatively high frequencies of annual exotic species likely will continue to dominate portions of the preserve experiencing early and mid-summer drawdown, at least in the short-term. Native perennial riparian/wet prairie species could potentially occupy these areas, but the high seed production and rapid germination of annual species following drawdown may prevent them from establishing. In addition to competition with annual species, establishment of the sedges (*Carex* sp.) that dominate wet prairie communities may be slowed as a result of their low seed production (Zedler 2000, Galatowitsch and Van der Valk 1996). Native perennial riparian/wet prairie species are probably also less tolerant of highly variable year-to-year water management than annual species since they make take several years to establish.

Hydrologically reconnected fields (Campfields, Riverbend, and South Marsh) experience a more consistent hydrologic regime and are more likely to develop a native riparian/wet prairie plant community. Other factors such as soil chemistry also may favor annual exotic forb species establishment. Soil nutrients at the preserve are high relative to other Upper Klamath Basin wetlands that were never used for agricultural production (Aldous et al. 2005, Graham et al. 2005). Increased nutrient additions have been shown to decrease wetland plant diversity and favor forbs over graminoids in wet prairies (Green and Galatowitsch 2002).

Other exotic species sampled include the perennial grasses *Phalaris arundinacea* and *Elytrigia repens*. *Phalaris arundinacea* is a facultative wetland species common throughout the preserve along levees but is also present at Riverbend, South Marsh, and Field 6. *Phalaris arundinacea* colonizes moist, bare ground and rapidly dominates native wetland plant communities (Green and Galatowitsch 2002). Complete eradication of this species is unlikely given its high frequency on levees at the preserve, other wetlands surrounding Upper Klamath Lake, and the riverbanks upstream along the Williamson River. However, efforts should be made to control its spread into the restored wetland fields while frequencies are still relatively low. *Elytrigia repens* is a facultative upland perennial grass that is widespread in the Upper fields and the upland portions of Campfields. This species is likely to remain a component of the vegetation in drier areas until efforts are made to restore upland plant communities.

4.4 Data interpretation, constraints, and recommendations for future monitoring

Data collected from vegetation monitoring plots at the Williamson River Delta Preserve provide important information about the response of plant communities to hydrologic restoration. However, data interpretation was constrained by inconsistencies in the field collection of the data, the timing of data collection, and limited hydrologic data. Three different teams collected the five years of vegetation monitoring data. In the first three years of data collection (2000-2002), a detailed description of the methods used was not recorded, and voucher plant specimens were not collected.

In contrast, a concerted effort was made to record the presence of each species, voucher specimens were collected, and a professional botanist was contracted to identify unknown specimens in 2003 and 2004. Thus, the accuracy of data collected in 2003 and 2004 is likely greater than in the previous years. Since it is unclear whether species identification and expended effort was consistent each year, it is possible that some of the year-to-year changes are due to differences in data collection rather than actual changes in species frequencies.

To improve consistency in future years, staff collecting monitoring data should follow a written protocol, provide field notes, and collect voucher specimens of new species. Improving hydrologic data collection will also aid interpretation of vegetation monitoring data. Gaps in hydrologic data limited the capacity to evaluate hydrologic effects on plant species establishment. Staff gauges should be installed prior to the initiation of seasonal flooding at the lowest possible elevation and surveyed yearly. At South Marsh, wetland plant species started to establish before the staff gauge was installed in 2003. This made it difficult to compare the levee breaching effects with the previous hydrologic regimes. At South Marsh and Riverbend, staff gauges are located above some vegetation plots making it impossible to determine water depths and hydrologic regime at those plots once water levels fall below the bottom of the staff gauge.

In spite of the possible inconsistencies in data collection and the recommendations for improvement, we are confident that the large-scale trends in plant community development reflect actual changes following restoration efforts.

Future vegetation monitoring at the existing plots should prioritize annual sampling at the early action projects (Campfields, Riverbend, and South Marsh). Sampling these areas only takes experienced staff six days, and provides important information on vegetation development in reconnected wetlands. Re-sampling the existing plots in the unconnected fields is no longer necessary now that the objective is to reconnect the entire delta. However, in all new reconnected areas, monitoring programs should include sampling the year prior to as well as the year following reconnection. This will provide pre-treatment data and more complete information about early-successional processes.

5. Key Findings and Implications

Distinct plant communities developed at the Williamson River Delta relative to water depth, flood duration, and drawdown timing. Wetland plant species establishment is expected to follow similar patterns at other restored wetlands adjacent to Upper Klamath Lake, Agency

Lake, and the Williamson River with similar hydrologic regimes. Key findings of this report that may interest others restoring wetlands in the region include:

Natural colonization is a viable means for restoring emergent wetland plant communities

Emergent wetland plant communities developed in areas with late summer to early fall drawdowns. Vegetation is dominated by native perennial wetland species common in adjacent lake-fringe wetlands. Exotic species are primarily limited to annuals such as *Chenopodium album* that germinate following drawdown. Native species including *Scirpus acutus*, *Typha latifolia*, and *Salix lasiandra* colonized during the first two years following initiation of seasonal flooding. Other native emergent species including *Eleocharis palustris*, *Alisma plantago-aquatica*, and *Sagittaria cuneata* established after three or more years and increased in cover gradually. Species richness continues to increase over time, particularly in areas that are hydrologically reconnected.

Transitional and deep water plant communities may not resemble potential plant communities[1] *in the short-term without active management*

Transitional plant communities developed between uplands and emergent wetlands in areas with early to mid-summer drawdowns. Vegetation is dominated by annual native (*Bidens cenura*) and exotic species (*Chenopodium album* and *Polygonum persicaria*). In some places, *Phalaris arundinaceae* (reed canary-grass) colonized, which can dominate if not controlled. Natural colonization by the native riparian/wet prairie species that could potentially occupy this zone may be slowed by limited seed dispersal (Zedler 2000, Galatowitsch and Van der Valk 1996) and competition with exotic species. Accelerating the development of riparian/wet prairie plant communities would require planting native species and controlling exotics.

Deep water plant communities could develop in areas that are inundated year-round or experience fall drawdowns. It still too early to determine what species will dominate this zone since the only deep water hydrologic zones at the Williamson River Delta were created at South Marsh following levee breaching in the fall of 2003. However, it is unlikely that *Nuphar lutea* ssp. *polysepala* (wocus/yellow pond lily), one of the dominant plant species historically found in deep water wetlands adjacent to Upper Klamath Lake, will colonize restored wetlands in the short-term, due to its limited dispersal mechanisms (Noble and Butler 1988, Thunhorst 1993). A study is currently underway at the Williamson to determine whether transplanting rhizomes is a viable method for establishing *Nuphar* (Elseroad et al. 2004b).

Hydrologic connection to adjacent water bodies may accelerate wetland plant development

Wetland plant species richness, cover and frequency were greatest at sites hydrologically connected to the Williamson River and Agency Lake compared to wetland fields that experience managed flooding. Hydrologic connection to adjacent water bodies likely

[1] Potential plant communities for each hydrologic zone at the Williamson River Delta are described in Elseroad (2004).

increases the quantity and diversity of water-born wetland plant propagules. It also provides a more consistent hydrologic regime. However, it is possible that managing water to mimic lake level fluctuations will achieve a similar vegetative response in unconnected wetlands. At the Williamson River Delta, the hydrologic regime in unconnected wetlands experienced high year-to-year variability which may favor exotic annual wetland species over native perennial wetland species.

6. Conclusions

Dramatic changes occurred within the past century at the Williamson River Delta. Although the delta probably will never return to its pre-agricultural condition, restoring hydrologic processes will benefit many wetland-dependent species. Vegetation in the wetland fields is dominated by native wetland plant species after only seven years of hydrologic restoration. Although exotic species dominate portions of the preserve, current trends indicate that native wetland plant species will continue to establish and expand, particularly in areas that are hydrologically reconnected to their adjacent water bodies.

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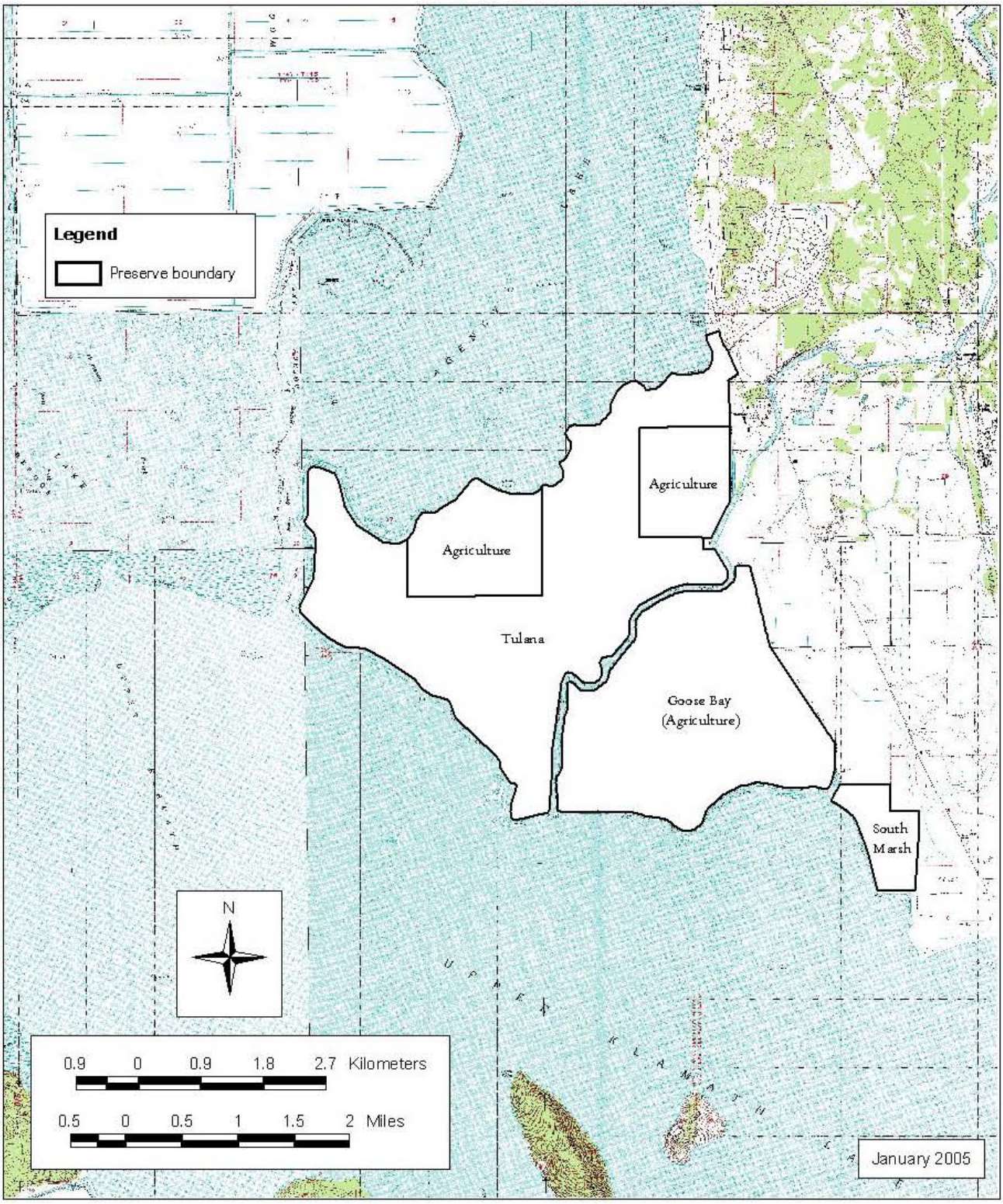
Figure 1. Location of the Williamson River Delta Preserve



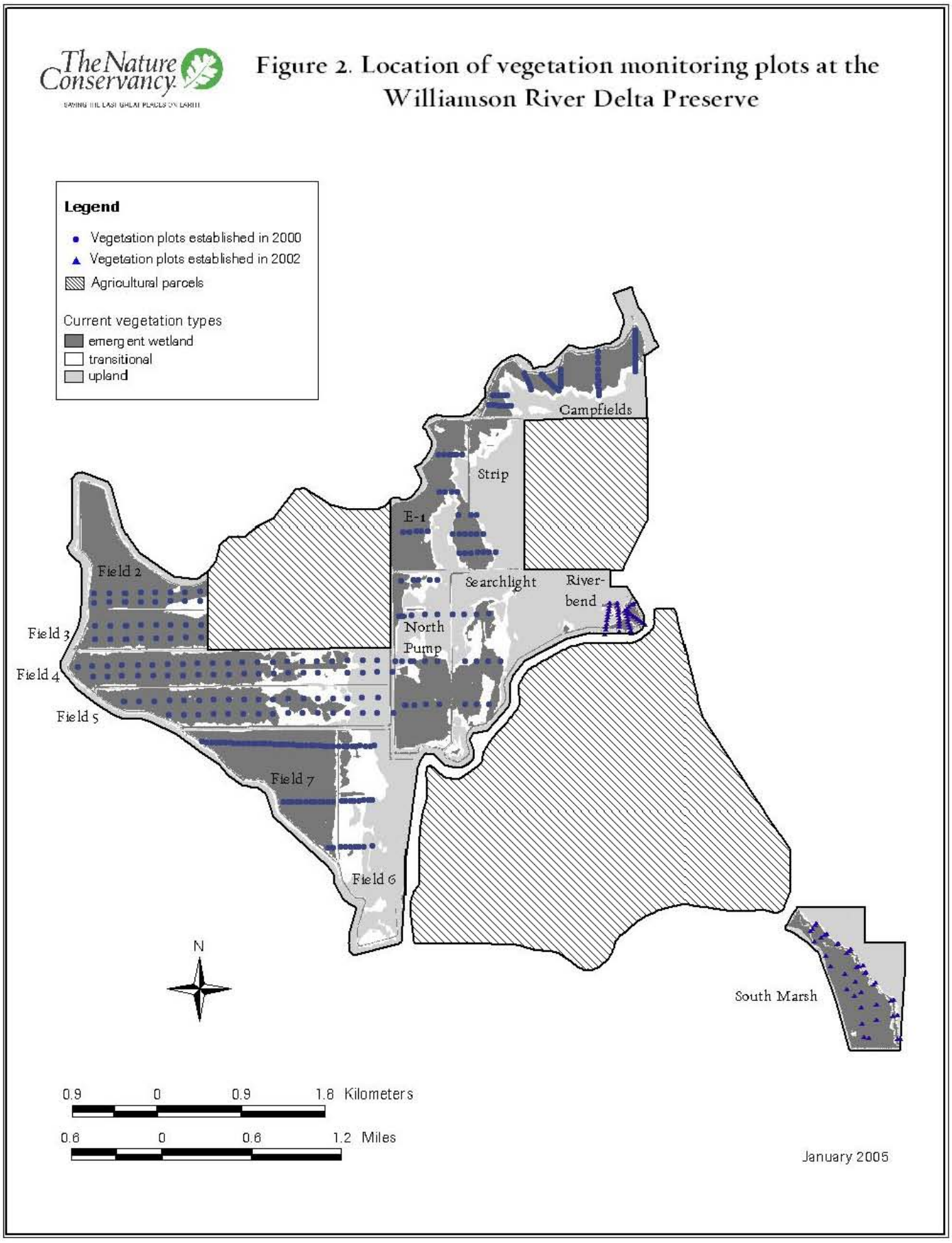

The Nature Conservancy
Figure 2. Location of vegetation monitoring plots at the Williamson River Delta Preserve
Legend
Vegetation plots established in 2000
Vegetation plots established in 2002
Agricultural parcels
Current vegetation types
emergent wetland
transitional
upland
Campfields
Strip
E-1
Searchlight
River-bend
North Pump
Field 2
Field 3
Field 4
Field 5
Field 7
Field 6
South Marsh
N
0.9 0 0.9 1.8 Kilometers
0.6 0 0.6 1.2 Miles
January 2005

Figure 3. Plant percent frequencies by guild collected in $3m^2$ quadrats from Fields 2-5 for years 2000, 2001, and 2003. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=106.

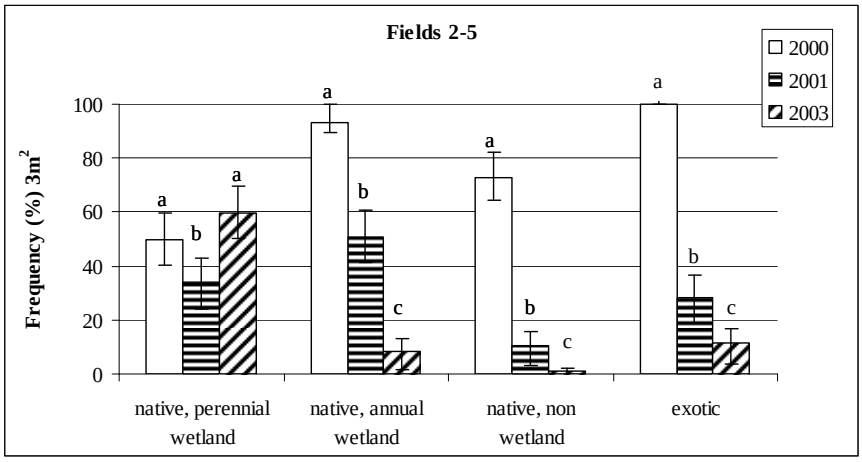


Figure 4. Native perennial wetland plant species percent frequencies collected in $3m^2$ quadrats from Fields 2-5 for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=106.

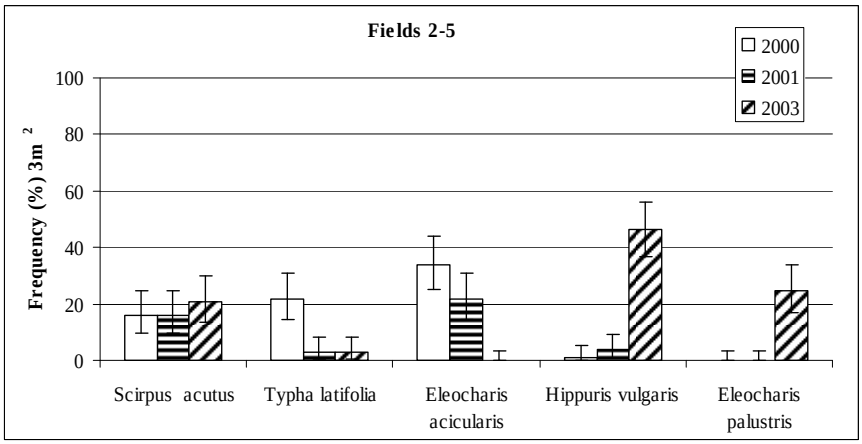


Figure 5. Exotic plant species percent frequencies collected in $3m^2$ quadrats from Fields 2-5 for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=106.

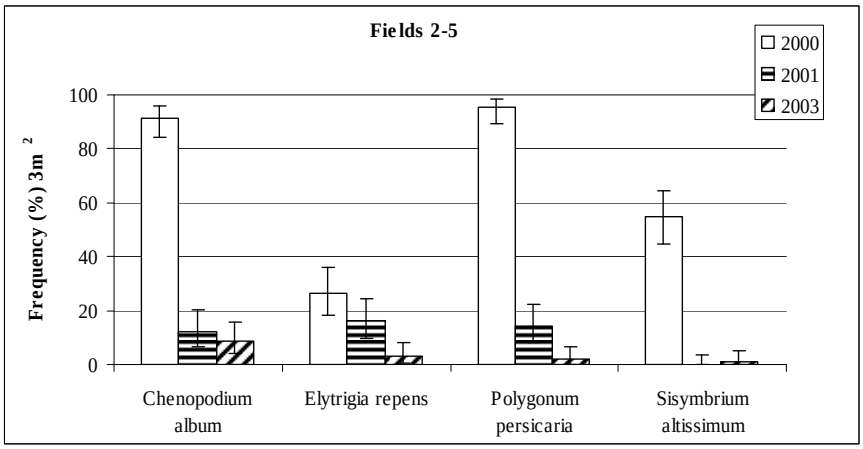


Figure 6. Plant percent frequencies by guild collected in $3m^2$ quadrats from Fields 6-7 for years 2000, 2001, and 2003. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=68.

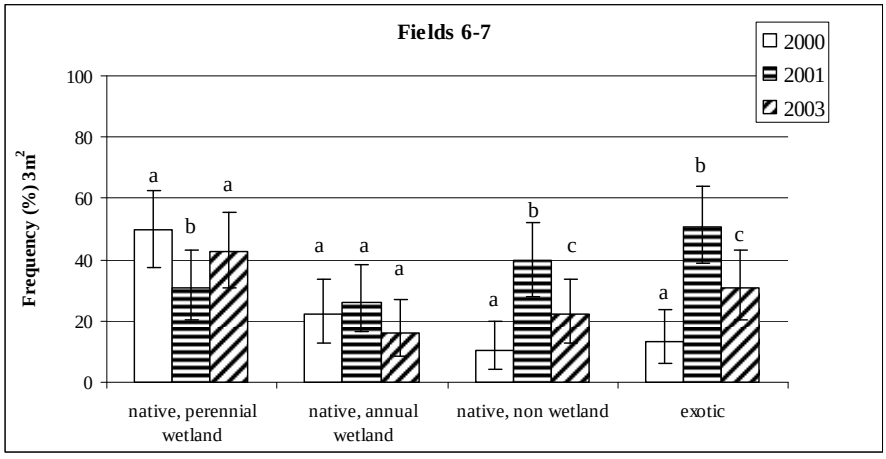


Figure 7. Native perennial wetland plant species percent frequencies in $3m^2$ quadrats from Fields 6-7 for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=68.

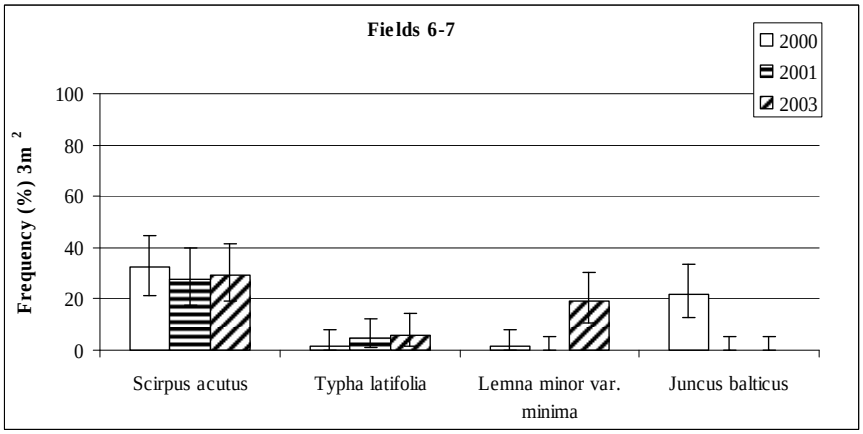


Figure 8. Exotic plant species percent frequencies in $3m^2$ quadrats from Fields 6-7 for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=68.

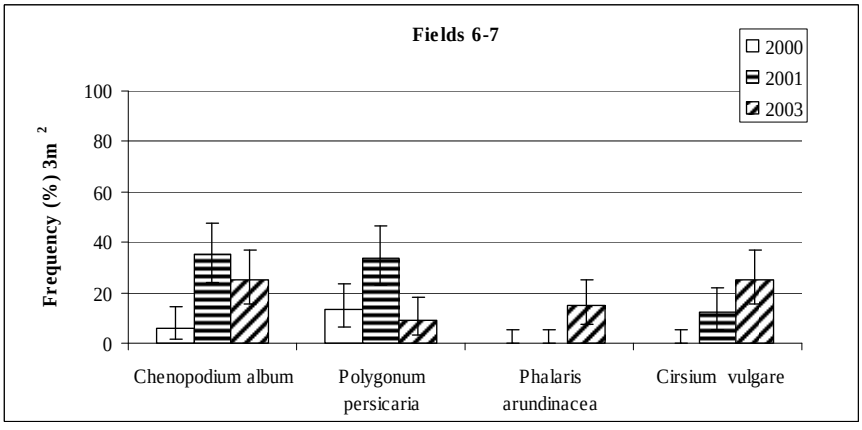


Figure 9. Plant percent frequencies by guild collected in $3m^2$ quadrats from Upper Fields for years 2000, 2001, and 2003. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=63.

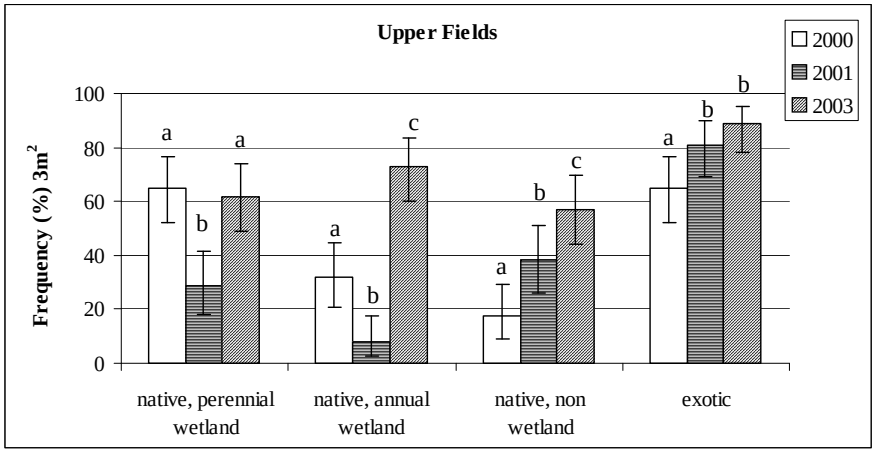


Figure 10. Native perennial wetland plant species percent frequencies in $3m^2$ quadrats from Upper Fields for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=63.

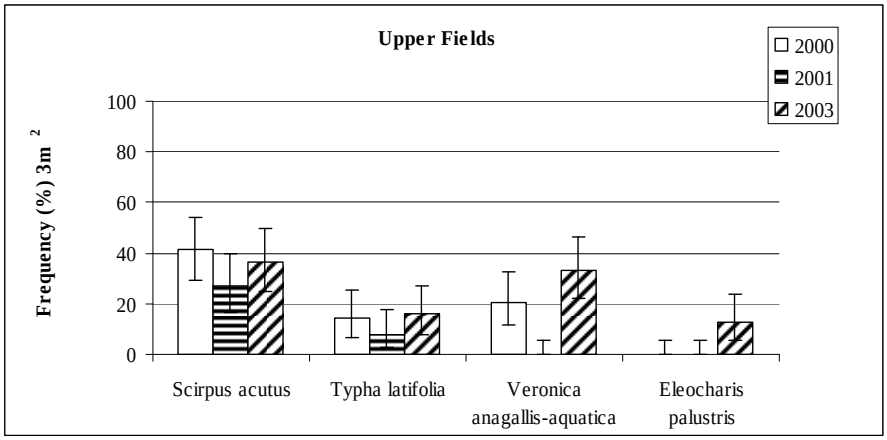


Figure 11. Exotic species plant species percent frequencies in $3m^2$ quadrats from the Upper Fields for years 2000, 2001, and 2003. Error bars represent 95% confidence intervals, n=63.

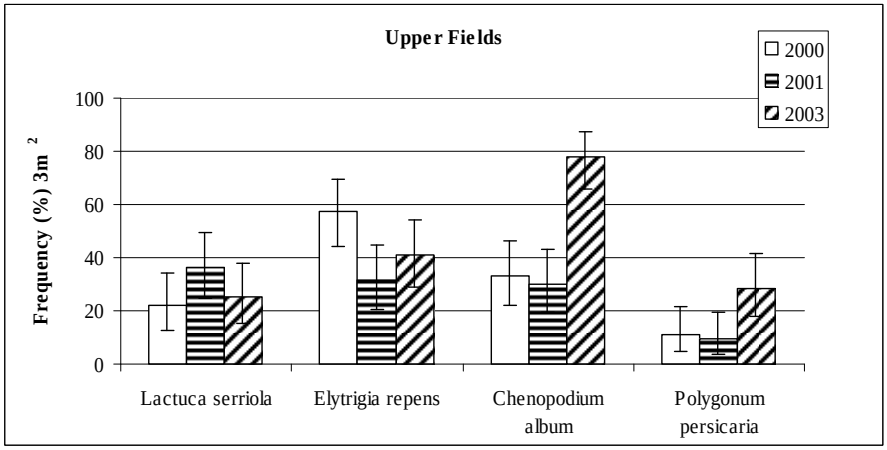


Figure 12. Plant percent frequencies by guild collected in $3m^2$ quadrats from Campfields for years 2000-2004. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=64.

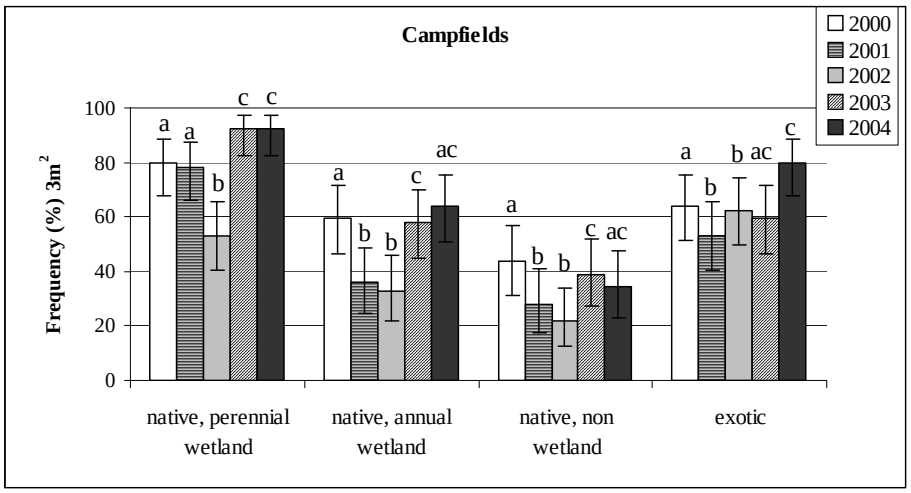


Figure 13. Native perennial wetland plant species percent frequencies in $3m^2$ quadrats from Campfields for years 2000-2004. Error bars represent 95% confidence intervals, n=64.

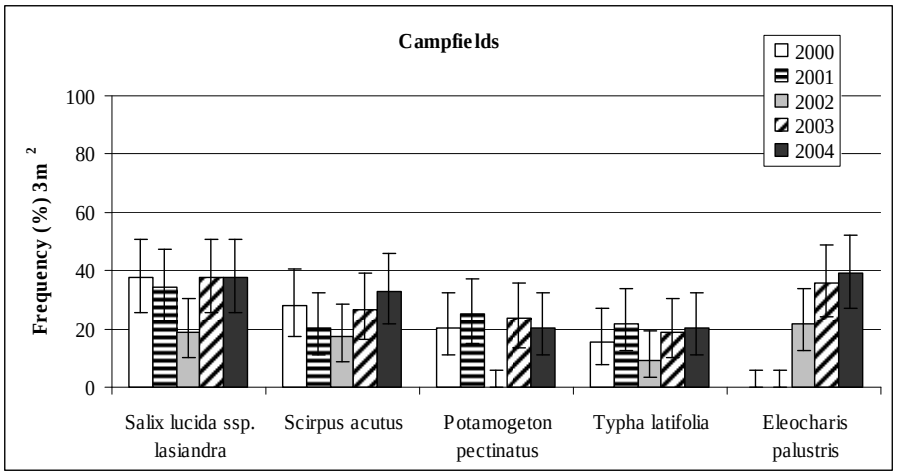


Figure 14. Exotic plant species percent frequencies in $3m^2$ quadrats from Campfields for years 2000-2004. Error bars represent 95% confidence intervals, n=64.

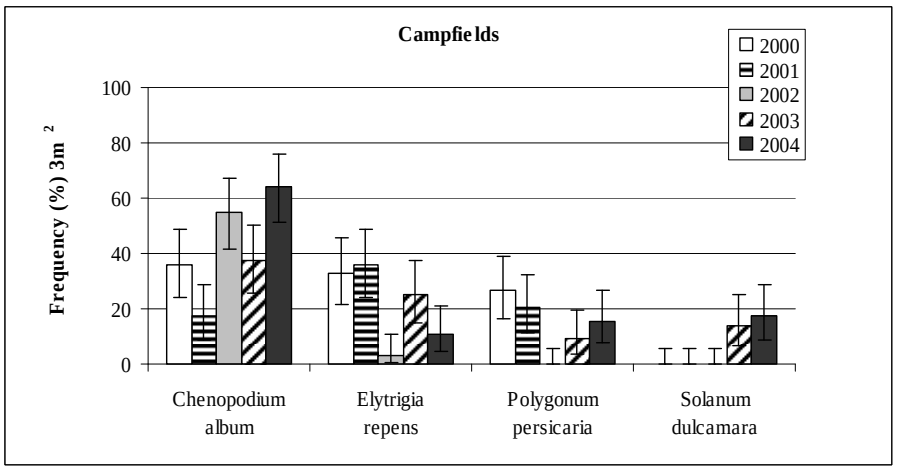


Figure 15. Plant percent frequencies by guild collected in $3m^2$ quadrats from Riverbend for years 2002-2004. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=45.

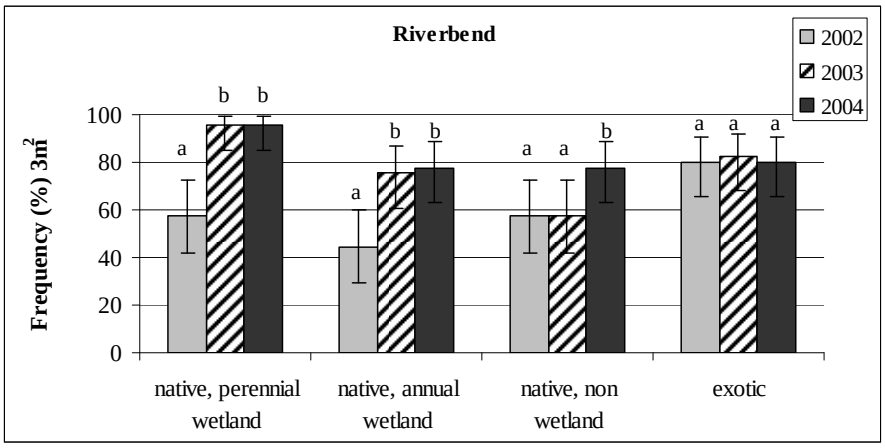


Figure 16. Native perennial wetland plant species percent frequencies in $3m^2$ quadrats from Riverbend for years 2002-2004. Error bars represent 95% confidence intervals, n=45.

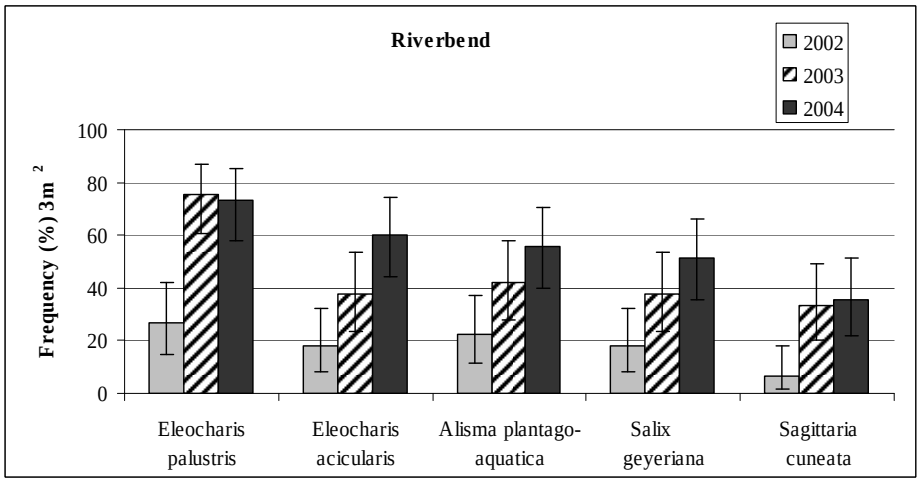


Figure 17. Exotic plant species percent frequencies in $3m^2$ quadrats from Riverbend for years 2002-2004. Error bars represent 95% confidence intervals, n=45.

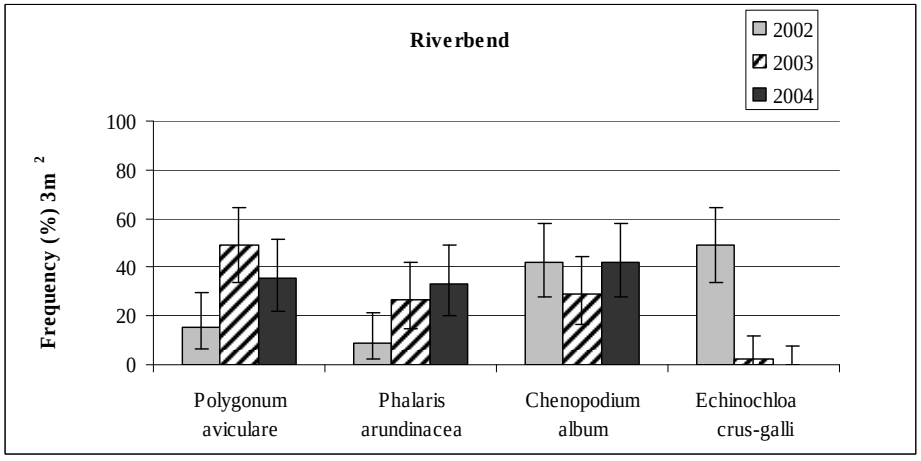


Figure 18. Plant percent frequencies by guild collected in $3m^2$ quadrats from South Marsh for years 2002-2004. Different letters represent significant differences ($p<0.05$). Error bars represent 95% confidence intervals, n=40.

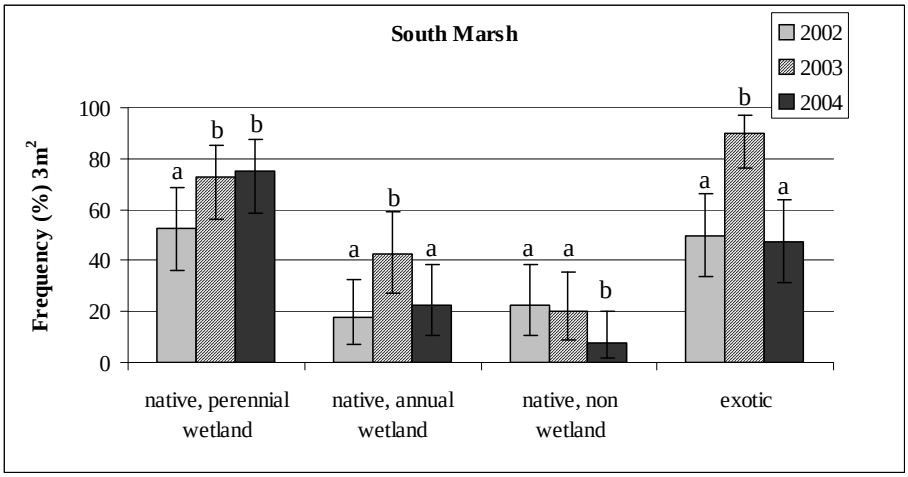


Figure 19. Native perennial wetland plant species percent frequencies in $3m^2$ quadrats from South Marsh for years 2002-2004. Error bars represent 95% confidence intervals, n=40.

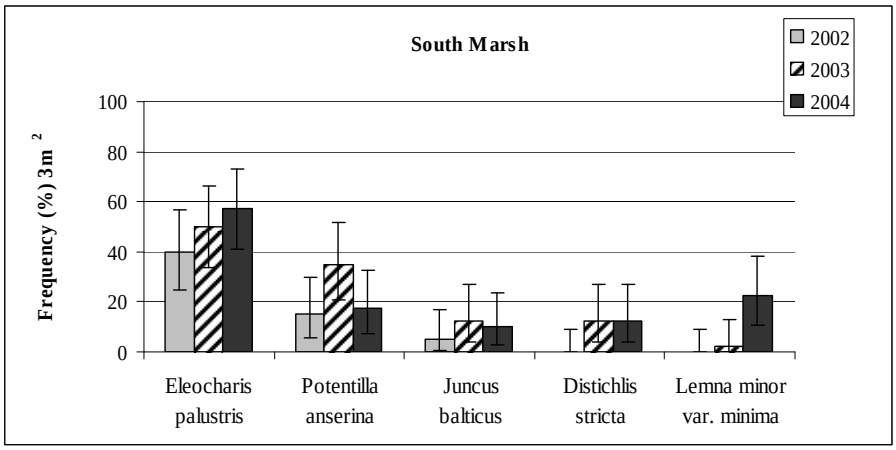


Figure 20. Exotic plant species percent frequencies in $3m^2$ quadrats from South Marsh for years 2002-2004. Error bars represent 95% confidence intervals, n=40.

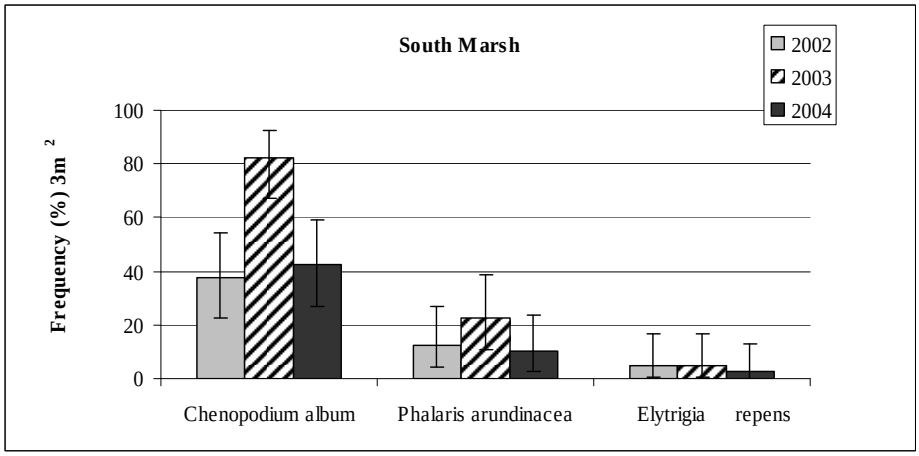


Table 1. Summary of hydrologic parameters (ft.) calculated from staff gauge data at Williamson River Delta Preserve 1998-2004. Minimum and maximum water depths are shown for the range of elevations at which vegetation monitoring plots are located. Drawdown refers to the month when standing surface water is no longer present.

		1998			1999			2000			2002			2003			2004		
Field name	Ground elevation	Min	Max	Draw-down	Min	Max	Draw-down	Min	Max	Draw-down	Min	Max	Draw-down	Min	Max	Draw-down	Min	Max	Draw-down
Fields 2-5	4132	0.0	2.2	July	0.0	3.3	Aug.	0.0	3.7	Sept.	0.0	3.7	Sept.	2.3	3.3	none	1.7	4.4	none
Fields 2-5	4133	0.0	1.2	June	0.0	2.3	Aug.	0.0	2.7	Aug.	0.0	2.7	Aug.	1.3	2.3	none	0.7	3.4	none
Fields 2-5	4134	0.0	0.2	May	0.0	1.3	July	0.0	1.7	May-July	0.0	1.7	July	0.3	1.3	none	0.0	2.4	Sept.
Fields 2-5	4135	0.0	0.0	dry	0.0	0.3	May	0.0	0.7	May-July	0.0	0.7	May	0.0	0.3	July	0.0	1.4	July
Fields 2-5	4136	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.4	June
Fields 6-7	4132	1.0	5.0	none	2.5	5.0	none	2.9	5.5	none	1.3	3.2	none	2.3	3.5	none	1.8	4.4	none
Fields 6-7	4133	0.0	4.0	July	1.5	4.0	none	1.9	4.5	none	0.3	2.2	none	1.3	2.5	none	0.8	3.4	none
Fields 6-7	4134	0.0	3.0	July	0.5	3.0	none	0.9	3.5	none	0.0	1.2	Aug.	0.3	1.5	none	0.0	2.4	Sept.
Fields 6-7	4135	0.0	2.0	July	0.0	2.0	Aug.	0.0	2.5	Oct.	0.0	0.2	May	0.0	0.5	July	0.0	1.4	July
Fields 6-7	4136	0.0	0.0	July	0.0	1.0	July	0.0	1.5	Aug.	0.0	0.0	dry	0.0	0.0	dry	0.0	0.4	June
Fields 6-7	4137	0.0	0.0	dry	0.0	0.0	April	0.0	0.5	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry
Fields 6-7	4138	0.0	0.0	dry	0.0	0.0	dry	0.0	0.5	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry
Upper Fields	4137	.	.	.	0.0	3.4	July	0.3	4.2	none	0.0	5.0	Dec.	0.0	4.9	July	0.0	3.9	Nov.
Upper Fields	4138	.	.	.	0.0	2.4	July	0.0	3.2	Dec.	0.0	4.0	Dec.	0.0	3.9	July	0.0	2.9	Oct.
Upper Fields	4139	.	.	.	0.0	1.4	April	0.0	2.2	Dec.	0.0	3.0	Sept.	0.0	2.9	July	0.0	1.9	Aug.
Upper Fields	4140	.	.	.	0.0	0.4	April	0.0	1.2	Oct.	0.0	2.0	Aug.	0.0	1.9	June	0.0	0.9	July
Upper Fields	4141	.	.	.	0.0	0.0	dry	0.0	0.2	July	0.0	1.0	July	0.0	0.9	June	0.0	0.0	dry
Upper Fields	4142+	.	.	.	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry
Campfields	4138	0.7	4.7	none	0.5	4.7	none	0.8	4.5	none	0.5	5.0	none	0.7	5.3	none	unk.	4.8	none
Campfields	4139	0.0	3.7	Oct.	0.0	3.7	Oct.	0.0	3.5	Oct.	0.0	4.0	Sept.	0.0	4.3	Oct.	unk.	3.8	Sept.
Campfields	4140	0.0	2.7	Oct.	0.0	2.7	Aug.	0.0	2.5	Aug.	0.0	3.0	Aug.	0.0	3.3	Aug.	0.0	2.8	Aug.
Campfields	4141	0.0	1.7	Oct.	0.0	1.7	July	0.0	1.5	July	0.0	2.0	Aug.	0.0	2.3	July	0.0	1.8	July
Campfields	4142	0.0	0.7	June	0.0	0.7	June	0.0	0.5	June	0.0	1.0	July	0.0	1.3	July	0.0	0.8	June
Campfields	4143	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.0	dry	0.0	0.3	June	0.0	0.0	dry
Riverbend	4138	.	.	.	.	.	.	.	.	.	0.5	5.1	none	0.7	5.4	none	unk.	4.8	none
Riverbend	4139	.	.	.	.	.	.	.	.	.	0.0	4.1	Sept.	0.0	4.4	Oct.	unk.	3.8	Sept.
Riverbend	4140	.	.	.	.	.	.	.	.	.	0.0	3.1	Aug.	0.0	3.4	Sept.	0.0	2.8	Aug.
Riverbend	4141	.	.	.	.	.	.	.	.	.	0.0	2.1	Aug.	0.0	2.4	Aug.	0.0	1.8	July
Riverbend	4142	.	.	.	.	.	.	.	.	.	0.0	1.1	July	0.0	1.4	July	0.0	0.8	June
Riverbend	4143	.	.	.	.	.	.	.	.	.	0.0	0.1	May	0.0	0.4	June	0.0	0.0	dry

Table 1. (cont.)

Field name	Ground elevation	1998 Min	1998 Max	1998 Draw-down	1999 Min	1999 Max	1999 Draw-down	2000 Min	2000 Max	2000 Draw-down	2002 Min	2002 Max	2002 Draw-down	2003 Min	2003 Max	2003 Draw-down	2004 Min	2004 Max	2004 Draw-down
South Marsh	4138	.	.	.	.	.	.	.	.	.	.	.	.	unk.	2.9	unk.	unk.	4.9	none
South Marsh	4139	.	.	.	.	.	.	.	.	.	.	.	.	unk.	1.9	unk.	0.0	3.9	Sept.
South Marsh	4140	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.9	July	0.0	2.9	Aug.
South Marsh	4141	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	dry	0.0	1.9	July
South Marsh	4142	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	dry	0.0	0.9	June
South Marsh	4143	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	dry	0.0	0.0	dry
South Marsh	4144	.	.	.	.	.	.	.	.	.	.	.	.	0.0	0.0	dry	0.0	0.0	dry

Table 2. Williamson River Delta Preserve plant species list. N=native, I=introduced, U=unknown, P=perennial, A=annual, B=biennial. "X" indicates species found in vegetation monitoring plots; other species found elsewhere on the preserve.

Genus	Species	Common name	Family	Or-igin	Dur-ation	Growth Habit	Wetland Status	Veg plots
Agrostis	exarata	spike bentgrass	Poaceae	N	P	graminoid	FACW	X
Agrostis	idahoensis	Idaho bentgrass	Poaceae	N	P	graminoid	FAC+	X
Agrostis	scabra	rough bentgrass	Poaceae	N	P	grass	FAC	X
Agrostis	stolonifera	creeping bentgrass	Poaceae	N	P	grass	FAC+	X
Alisma	plantago-aquatica	American water-plantain	Alistmataceae	N	P	forb	OBL	X
Alopecurus	aequalis	shortawn foxtail	Poaceae	N	P	graminoid	OBL	X
Alopecurus	pratensis	meadow foxtail	Poaceae	I	P	graminoid	FACW	X
Amaranthus	albus	prostrate pigweed	Amaranthaceae	N	A	forb	FACU	X
Amaranthus	powellii	Powell's amaranth	Amaranthaceae	N	A	forb	UPL	X
Amsinckia	menziesii var. intermedia	common fiddleneck	Boraginaceae	N	A	forb	UPL	X
Artemisia	biennis	biennial wormwood	Asteraceae	N	A/B	forb	FACW	X
Atriplex	patula	spear saltbush	Chenopodiaceae	N	A	forb	FACW	
Avena	sativa	common oat	Poaceae	I	A	graminoid	UPL	X
Azolla	mexicana	Mexican mosquitofern	Azollaceae	N	A/P	forb	OBL	X
Bechmannia	syziachne	American sloughgrass	Poaceae	N	A	graminoid	OBL	X
Bidens	cernua	nodding beggarticks	Asteraceae	N	A	forb	FACW+	X
Bidens	frondosa	devil beggarticks	Asteraceae	N	A	forb	FACW+	X
Brassica	rapa	field mustard	Brassicaceae	I	A	forb	UPL	X
Bromus	tectorum	cheatgrass	Poaceae	I	A	graminoid	UPL	X
Capsella	bursa	shepard's purse	Brassicaceae	I	A	forb	FAC-	X
Carex	angustata	widefruit sedge	Cyperaceae	N	P	graminoid	FACW+	X
Carex	athrostachya	slenderbeak sedge	Cyperaceae	N	P	graminoid	FACW	X
Carex	cusickii	Cusick's sedge	Cyperaceae	N	P	graminoid	OBL	X
Carex	feta	green-sheathed sedge	Cyperaceae	N	P	graminoid	FACW	X
Ceratophyllum	dermersum	coontail	Ceratophyllaceae	N	P	forb	OBL	X
Chamomilla	suaveolens	disc mayweed	Asteraceae	I	A	forb	FACU	X
Chenopodium	album	lambsquarters	Chenopodiaceae	I	A	forb	FAC	X
Chenopodium	atrovirens	pinyon goosefoot	Chenopodiaceae	N	A	forb	none	X
Chenopodium	foliosum	leafy goosefoot	Chenopodiaceae	I	A	forb	none	
Chenopodium	fremonti	Fremont's goosefoot	Chenopodiaceae	N	A	forb	FACU	
Chenopodium	leptophyllum var. oblongifolium	narrowleaf goosefoot	Chenopodiaceae	N	A	forb	FACU	X
Cirsium	arvense	Canada thistle	Asteraceae	I	P	forb	FACU+	X
Cirsium	vulgare	bull thistle	Asteraceae	I	B	forb	FACU	X
Conyza	canadensis	Canadian horseweed	Asteraceae	N	A/B	forb	FACU	X
Cryptantha	sp.	Cryptantha	Boraginaceae	U	U	forb	U	X
Cryptantha	ambigua	basin cryptantha	Boraginaceae	N	A	forb	none	X
Cuscuta	californica	chaparral dodder	Cuscutaceae	N	P	forb/vine	none	
Cyperus	aristatus	bearded flatsedge	Cyperaceae	N	A	graminoid	OBL	X
Descurania	sophia	herb sophia	Brassicaceae	I	A/B	forb	none	X
Dipsacus	fullonum	Teasel	Dipsacaceae	I	B	forb	none	
Distichlis	stricta	inland saltgrass	Poaceae	N	P	graminoid	FACW	X
Downingia	concolor	maroonspot calicoflower	Campanulaceae	N	A	forb	OBL	
Echinochloa	crus-galli	large barnyard grass	Poaceae	I	A	graminoid	FACW	X
Elatine	sp.	waterwort	Elatinaceae	U	U	forb	OBL	X
Elatine	californica	California waterwort	Elatinaceae	N	A	forb	OBL	X

Table 2. (cont.)

Genus	Species	Common name	Family	Origin	Duration	Growth Habit	Wetland Status	Veg plots
Eleocharis	acicularis	needle spike-rush	Cyperaceae	N	P	graminoid	OBL	X
Eleocharis	palustris	creeping spike-rush	Cyperaceae	N	P	graminoid	OBL	X
Elodea	canadensis	Canadian waterweed	Hydrocharitaceae	N	P	forb	OBL	X
Elytrigia	repens	quackgrass	Poaceae	I	P	graminoid	FACU	X
Epilobium	angustfolium	fireweed	Onagraceae	N	P	forb	FACU+	X
Epilobium	ciliatum ssp. watsonii	fringed willowherb	Onagraceae	N	P	forb	FACW-	X
Epilobium	paniculatum	tall annual willowherb	Onagraceae	N	A	forb	UPL	X
Equisetum	arvense	common horsetail	Equisetaceae	N	P	N/A	FAC	X
Eragrostis	cilianensis	Janchen stinkgrass	Poaceae	I	A	graminoid	FACU	X
Ericameria	nauseosa	rubber rabbitbrush	Asteraceae	N	P	shrub	none	
Erigeron	philadelphicus	Philadelphia fleabane	Asteraceae	N	P/B	forb	FACU	X
Erodium	cicutarium	redstem stork's bill	Geraniaceae	I	A/B	forb	none	
Erysimum	cheiranthoides	wormseed wallflower	Brassicaceae	I	A/B	forb	FACU	X
Euphorbia	serpyllifolia	thymeleaf sandmat	Euphorbiaceae	N	A	forb	none	X
Euthamia	occidentalis	western goldtop	Asteraceae	N	P	forb	FACW	
Galium	aparine	common bedstraw	Rubiaceae	N	A	forb	FACU	X
Galium	trifidum	threepetal bedstraw	Rubiaceae	N	P	forb	FACW+	X
Gnaphalium	palustre	western marsh cudweed	Asteraceae	N	A	forb	FAC+	X
Gratiola	neglecta	clammy hedgehyssop	Scrophulariaceae	N	A	forb	OBL	X
Helenium	autumnale	common sneezeweed	Asteraceae	N	P	forb	FACW	X
Helianthus	annus	common sunflower	Asteraceae	N	A	forb	FACU-	X
Helianthus	bolanderi	serpentine sunflower	Asteraceae	N	A	forb	UPL	X
Heliotropium	curassavicum var. obovatum	seaside heliotrope	Boraginaceae	N	A/P	forb/shrub	OBL	
Hippuris	vulgaris	common mare's tail	Hippuridaceae	N	P	forb	OBL	X
Hordeum	jubatum	foxtail barley	Poaceae	N	P	graminoid	FAC+	X
Horkelia	fusca	pinewoods horkelia	Roseaceae	N	P	forb	none	
Juncus	balticus	Baltic rush	Juncaceae	N	P	graminoid	OBL	X
Juncus	bufonius	toad rush	Juncaceae	N	A	graminoid	FACW+	
Kochia	scoparia	Mexican-fireweed	Chenopodiaceae	I	A	forb	FAC	
Lactuca	serriola	prickly lettuce	Asteraceae	I	A/B	forb	FAC-	X
Lemna	minor var. minima	common duckweed	Lemnaceae	N	P	forb	OBL	X
Limosella	aquatica	water mudwort	Scrophulariaceae	N	A	forb	OBL	X
Lolium	arundinaceum	tall fescue	Poaceae	I	P	graminoid	FACU-	X
Lotus	purshianus	American bird's-foot trefoil	Fabaceae	N	A	forb	none	X
Ludwigia	palustris	marsh seedbox	Onagraceae	N	P	forb	OBL	X
Lycopus	asper	rough bugleweed	Lamiaceae	N	P	forb	OBL	X
Malva	neglecta	common mallow	Malvaceae	I	A/P/B	forb	none	X
Matricaria	maritima	false mayweed	Asteraceae	I	A/B/P	forb	FACU	X
Medicago	sativa	alfalfa	Fabaceae	I	A/P	forb	UPL	X
Melilotus	officinalis	yellow sweetclover	Fabaceae	I	A/B/P	forb	FACU	X
Mentha	arvensis	wild mint	Lamiaceae	N	P	forb	FACW-	X
Mimulus	guttatus	seep monkeyflower	Scrophulariaceae	N	A/P	forb	OBL	
Muhlenbergia	filiformis	pullup muhly	Poaceae	N	A	graminoid	FACW	X
Myriophyllum	sibiricum	shortspike watermilfoil	Haloragaceae	N	P	forb	OBL	X
Panicum	capillare	witchgrass	Poaceae	N	A	graminoid	FAC	X
Phalaris	arundinacea	reed canary-grass	Poaceae	I	P	graminoid	FACW	X
Phragmities	australis	common reed	Poaceae	N		forb	FACW+	
Pinus	ponderosa	ponderosa pine	Pinaceae	N	P	tree	UPL	

Table 2. (cont.)

Genus	Species	Common name	Family	Origin	Duration	Growth Habit	Wetland Status	Veg plots
Plantago	major	common plantain	Plantaginaceae	N	P	forb	FAC+	X
Poa	pratensis	Kentucky bluegrass	Poaceae	I	P	graminoid	FACU+	X
Poa	secunda	Sandberg bluegrass	Poaceae	N	P	graminoid	FACU	X
Polygonum	amphibium	water smartweed	Polygonaceae	N	P	forb	OBL	X
Polygonum	aviculare	prostrate knotweed	Polygonaceae	I	A/P	forb	FACW-	X
Polygonum	hydropiperoides	swamp smartweed	Polygonaceae	N	P	forb	OBL	X
Polygonum	lapathifolium	curlytop knotweed	Polygonaceae	N	A	forb	FACW+	X
Polygonum	persicaria	spotted ladysthumb	Polygonaceae	I	A/P	forb	FACW	X
Polygonum	amphibium var. emersum	longroot smartweed	Polygonaceae	N	P	forb	OBL	
Polygonum	amphibium var. stipulaceum	water smartweed	Polygonaceae	N	P	forb	OBL	
Polygonum	cuspidatum	Japanese knotweed	Polygonaceae	I	P	forb/shrub	NI	
Polypogon	monspeliensis	annual rabbitsfoot grass	Poaceae	I	A	graminoid	FACW+	X
Populus	sp.		Salicaceae	U	P	tree	U	X
Potamogeton	crispus	curly pondweed	Potamogetonaceae	I	P	forb	OBL	X
Potamogeton	epihydrus	ribbonleaf pondweed	Potamogetonaceae	N	P	forb	OBL	
Potamogeton	natans	floating-leaf pondweed	Potamogetonaceae	N	P	forb	OBL	X
Potamogeton	pectinatus	leafy pondweed	Potamogetonaceae	N	P	forb	OBL	X
Potentilla	anserina	silverweed cinquefoil	Roseaceae	N	P	forb	OBL	X
Potentilla	norvegica	Norwegian cinquefoil	Rosaceae	N	A/B/P	forb	FAC	X
Puccinellia	lemmonii	Lemmon's alkaligrass	Poaceae	N	P	graminoid	FAC	X
Ranunculus	aquatilis	whitewater crowfoot	Ranunculaceae	N	P	forb	OBL	X
Ranunculus	sceleratus	cursed buttercup	Ranunculaceae	N	A/P	forb	OBL	X
Ranunculus	cymbalaria	alkali buttercup	Ranunculaceae	N	P	forb	OBL	X
Rorippa	curvisiliqua	curvepod yellowcress	Brassicaceae	N	A/B	forb	FACW+	X
Rorippa	sphaerocarpa	roundfruit yellowcress	Brassicaceae	N	A	forb	FAC+	
Rorippa	nasturtium-aquaticum	watercress	Brassicaceae	N	P	forb	OBL	
Rumex	crispus	curly dock	Polygonaceae	I	P	forb	FACW	X
Rumex	maritimus	golden dock	Polygonaceae	N	A/B	forb	FACW+	X
Sagittaria	cuneata	arumleaf arrowhead	Alistmataceae	N	P	forb	OBL	X
Salix	geyeriana	Geyer's willow	Salicaceae	N	P	tree/shrub	FACW+	X
Salix	lucida ssp. lasiandra	Pacific willow	Salicaceae	N	P	tree/shrub	FACW+	X
Scirpus	acutus	hardstem bulrush	Cyperaceae	N	P	graminoid	OBL	X
Scirpus	americanus	chairmaker's bulrush	Cyperaceae	N	P	graminoid	OBL	X
Scirpus	maritimus	cosmopolitan bulrush	Cyperaceae	N	P	graminoid	OBL	X
Sisymbrium	altissimum	tall tumblemustard	Brassicaceae	I	A/B	forb	FACU-	X
Smilacina	sp.		Liliaceae	U	U	forb	U	X
Solanum	dulcamara	climbing nightshade	Solonaceae	I	P	forb/subshrub	FAC	X
Solanum	sarrachoides	hoe nightshade	Solanaceae	N	A	forb	UPL	X
Sonchus	asper	spiny sowthistle	Asteraceae	I	A	forb	FAC-	X
Sparganium	eurycarpum	giant bur-reed	Sparganiaceae	N	P	forb	OBL	X
Suaeda	occidentalis	Pursh seepweed	Chenopodiaceae	N	A/P	forb	FACW	X
Symphyotrichum	frondosum	short-rayed alkalai aster	Asteraceae	N	A	forb	FACW+	X
Thlaspi	arvense	field pennycress	Brassicaceae	I	A	forb	NI	
Tragopogon	dubius	yellow salsify	Asteraceae	I	A/B	forb	none	
Trifolium	repens	white clover	Fabaceae	I	P	forb	FACU+	X
Typha	latifolia	broadleaf cattail	Typhaceae	N	P	forb	OBL	X
Urtica	dioica	stinging nettle	Urticaceae	N	P	forb	FAC+	X
Verbascum	thapsus	mullein	Scrophulariaceae	I	B	forb	UPL	X
Veronica	anagallis-aquatica	water speedwell	Scrophulariaceae	N	P/B	forb	OBL	X

Table 3. Species richness (# species) in vegetation monitoring plots 2000-2004.

Field name	Year	native perennial wetland	native annual wetland	native non-wetland	exotic	unknown guild	all species
Fields 2-5	2000	8	2	6	14	3	33
Fields 2-5	2001	8	2	4	10	2	26
Fields 2-5	2003	11	4	2	9	1	27
Fields 6-7	2000	9	2	4	9	1	25
Fields 6-7	2001	5	2	7	9	2	25
Fields 6-7	2003	8	3	8	9	0	28
Upper Fields	2000	15	2	7	11	3	38
Upper Fields	2001	3	2	7	12	1	25
Upper Fields	2003	11	5	14	15	2	47
Campfields	2000	10	2	11	13	2	38
Campfields	2001	9	2	10	12	4	37
Campfields	2002	11	3	8	6	0	28
Campfields	2003	19	8	10	16	5	58
Campfields	2004	17	8	8	11	2	46
Riverbend	2002	12	5	7	12	0	36
Riverbend	2003	24	10	16	19	4	73
Riverbend	2004	23	12	13	19	5	72
South Marsh	2002	5	1	4	5	1	16
South Marsh	2003	11	5	4	6	2	28
South Marsh	2004	13	6	4	7	3	33

Table 4. Plant species and guild frequencies and cover for Fields 2-5 at the Williamson River Delta Preserve monitoring plots in 2000, 2001, and 2003. Values are % frequency and cover in vegetation monitoring plots.

Species	Guild code	Freq $3m^2$ 2000	Freq $3m^2$ 2001	Freq $3m^2$ 2003	Freq $1m^2$ 2003	Avg. cover $1m^2$ 2003
Alisma plantago-aquatica	N,PW	0.94	0.00	1.89	0.00	0.00
Amaranthus powellii	N,NW	9.43	0.00	0.00	0.00	0.00
Amsinckia menziesii var. intermedia	N,NW	0.00	0.00	0.94	0.94	0.19
Annual forb	U	0.00	0.00	1.89	1.89	0.08
Avena sativa	E	1.89	0.94	0.00	0.00	0.00
Bidens cernua	N,AW	62.26	10.38	3.77	2.83	1.32
Bidens frondosa	N,AW	0.00	0.00	3.77	1.89	0.01
Brassica rapa	E	14.15	1.89	0.00	0.00	0.00
Carex sp	N,PW	1.89	0.00	0.00	0.00	0.00
Ceratophyllum dermersum	N,PW	0.00	0.94	0.00	0.00	0.00
Chamomilla suaveolens	E	0.00	0.94	0.94	0.00	0.00
Chenopodium album	E	91.51	12.26	8.49	6.60	2.81
Cirsium vulgare	E	2.83	0.94	1.89	0.00	0.00
Eleocharis acicularis	N,PW	33.96	21.70	0.00	0.00	0.00
Eleocharis palustris	N,PW	0.00	0.00	24.53	18.87	4.84
Elodea canadensis	N,PW	0.00	0.00	4.72	4.72	0.60
Elytrigia repens	E	26.42	16.04	2.83	0.94	0.03
Eragrostis cilianensis	E	28.30	0.00	0.00	0.00	0.00
Erigeron philadelphicus	N,NW	13.21	9.43	0.00	0.00	0.00
Gnaphalium palustre	N,NW	13.21	0.00	0.00	0.00	0.00
Hippuris vulgaris	N,PW	0.94	3.77	46.23	36.79	16.52
Hordeum jubatum	E	2.83	0.00	0.00	0.00	0.00
Lactuca serriola	E	4.72	2.83	0.00	0.00	0.00
Lemna minor var. minima	N,PW	0.00	0.00	15.09	15.09	1.52
Malva neglecta	E	0.00	0.00	0.94	0.00	0.00
Panicum capillare	N,NW	62.26	0.94	0.00	0.00	0.00
Poa pratensis	E	15.09	0.00	0.00	0.00	0.00
Poa secunda	N,NW	6.60	1.89	0.00	0.00	0.00
Polygonum amphibium	N,PW	0.00	0.00	7.55	3.77	0.33
Polygonum persicaria	E	95.28	14.15	1.89	0.94	0.01
Polypogon monspeliensis	E	0.94	0.00	0.00	0.00	0.00
Potamogeton natans	N,PW	0.00	1.89	0.00	0.00	0.00
Potamogeton pectinatus	N,PW	0.00	3.77	9.43	8.49	2.00
Potentilla norvegica	N,NW	8.49	0.94	0.00	0.00	0.00
Ranunculus sceleratus	N,PW	2.83	0.00	0.00	0.00	0.00
Rorippa sp.	U	10.38	0.94	0.00	0.00	0.00
Rumex crispus	E	0.94	8.49	0.00	0.00	0.00
Rumex maritimus	N,AW	90.57	45.28	5.66	1.89	0.28
Salix lucida ssp. lasiandra	N,PW	0.94	0.94	0.94	0.00	0.00
Scirpus acutus	N,PW	16.04	16.04	20.75	10.38	3.02
Scirpus maritimus	N,PW	0.00	0.00	6.60	5.66	0.40
Sisymbrium altissimum	E	54.72	0.00	0.94	0.00	0.00
Solanum dulcamara	E	0.00	0.00	0.94	0.00	0.00
Sonchus asper	E	5.66	2.83	0.94	0.00	0.00
Symphyotrichum frondosum	N,AW	0.00	0.00	2.83	0.94	0.08
Typha latifolia	N,PW	21.70	2.83	2.83	1.89	0.40
Unk forb	U	3.77	3.77	0.00	0.00	0.00

Table 4. (cont.)

Species	Guild code	Freq 3m^2 2000	Freq 3m^2 2001	Freq 3m^2 2003	Freq 1m^2 2003	Avg. cover 1m^2 2003
Unk grass	U	29.25	0.00	0.00	0.00	0.00
Urtica dioica	N,NW	0.00	0.00	0.94	0.00	0.00
Guild summary						
native perennial wetland	N,PW	50.00	33.96	59.43	52.83	29.62
native annual wetland	N,AW	93.40	50.94	8.49	4.72	1.70
native non-wetland	N,NW	72.64	10.38	0.94	0.94	0.19
Exotic	E	100.00	28.30	11.32	7.55	2.85
Plot cover						
All plants						34.43
Bare ground						0.75
Litter						2.39
Water						65.94

Table 5. Plant species and guild frequencies and cover for Fields 6-7 at the Williamson River Delta Preserve monitoring plots in 2000, 2001, and 2003. Values are % frequency and cover.

Species	Guild code	Freq $3m^2$ 2000	Freq $3m^2$ 2001	Freq $3m^2$ 2003	Freq $1m^2$ 2003	Avg. cover $1m^2$ 2003
Agrostis exarata	N,PW	0.00	0.00	2.94	1.47	0.00
Agrostis idahoensis	N,NW	0.00	0.00	0.00	0.00	0.00
Agrostis scabra	N,NW	0.00	0.00	1.47	0.00	0.00
Amsinckia menziesii var. intermedia	N,NW	0.00	1.54	0.00	0.00	0.00
Avena sativa	E	1.47	0.00	0.00	0.00	0.00
Bidens cernua	N,AW	17.65	10.77	14.71	13.24	1.94
Brassica rapa	E	0.00	1.54	0.00	0.00	0.00
Carex angustata	N,PW	0.00	0.00	1.47	1.47	0.06
Carex sp.	N,PW	1.47	1.54	0.00	0.00	0.00
Chamomilla suaveolens	E	1.47	0.00	0.00	0.00	0.00
Chenopodium album	E	5.88	35.38	25.00	19.12	4.07
Chenopodium atrovirens	N,NW	0.00	0.00	1.47	1.47	0.00
Cirsium vulgare	E	0.00	12.31	25.00	19.12	5.23
Eleocharis acicularis	N,PW	10.29	1.54	0.00	0.00	0.00
Eleocharis palustris	N,PW	0.00	0.00	4.41	2.94	0.59
Elytrigia repens	E	1.47	3.08	0.00	0.00	0.00
Epilobium ciliatum ssp. watsonii	N,NW	0.00	0.00	4.41	1.47	0.00
Epilobium paniculatum	N,NW	0.00	0.00	7.35	2.94	0.07
Erigeron philadelphicus	N,NW	1.47	6.15	0.00	0.00	0.00
Erysimum cheiranthoides	E	0.00	0.00	1.47	1.47	0.01
Gnaphalium palustre	N,NW	7.35	10.77	4.41	2.94	0.96
Juncus balticus	N,PW	22.06	0.00	0.00	0.00	0.00
Lactuca serriola	E	1.47	6.15	2.94	1.47	0.51
Lemna minor var. minima	N,PW	1.47	0.00	19.12	19.12	4.73
Myriophyllum sibiricum	N,PW	4.41	0.00	0.00	0.00	0.00
Panicum capillare	N,NW	4.41	20.00	5.88	5.88	0.15
Phalaris arundinacea	E	0.00	0.00	14.71	8.82	4.34
Poa pratensis	E	1.47	0.00	0.00	0.00	0.00
Poa secunda	N,NW	4.41	15.38	0.00	0.00	0.00
Polygonum amphibium	N,PW	0.00	0.00	2.94	1.47	0.07
Polygonum persicaria	E	13.24	33.85	8.82	8.82	0.53
Polypogon monspeliensis	E	0.00	3.08	0.00	0.00	0.00
Potamogeton pectinatus	N,PW	0.00	0.00	1.47	1.47	0.01
Potentilla norvegica	N,NW	0.00	4.62	4.41	4.41	0.02
Ranunculus sceleratus	N,PW	4.41	0.00	0.00	0.00	0.00
Rorippa curvisiliqua	N,AW	0.00	0.00	2.94	2.94	0.41
Rorippa sp.	U	0.00	13.85	0.00	0.00	0.00
Rumex crispus	E	0.00	13.85	0.00	0.00	0.00
Rumex maritimus	N,AW	14.71	20.00	10.29	10.29	3.66
Salix lucida ssp. lasiandra	N,PW	1.47	1.54	0.00	0.00	0.00
Scirpus acutus	N,PW	32.35	27.69	29.41	26.47	15.15
Sisymbrium altissimum	E	1.47	0.00	8.82	4.41	1.35
Solanum dulcamara	E	0.00	0.00	5.88	2.94	0.54
Sonchus asper	E	4.41	1.54	8.82	2.94	0.02
Typha latifolia	N,PW	1.47	4.62	5.88	1.47	0.10
Unk forb	U	0.00	1.54	0.00	0.00	0.00
Unk grass	U	1.47	0.00	0.00	0.00	0.00
Urtica dioica	N,NW	0.00	1.54	1.47	1.47	0.06

Table 5. (cont.)

Species	Guild code	Freq 3m^2 2000	Freq 3m^2 2001	Freq 3m^2 2003	Freq 1m^2 2003	Avg. cover 1m^2 2003
Guild summary						
native perennial wetland	N,PW	50.00	30.77	42.65	39.71	20.72
native annual wetland	N,NW	22.06	26.15	16.18	14.71	6.01
native non-wetland	N,AW	10.29	40.00	22.06	14.71	1.26
Exotic	E	13.24	50.77	30.88	30.88	16.62
Plot cover						
All plants						44.61
Bare ground						5.65
Litter						9.24
Water						45.10

Table 6. Plant species and guild frequencies and cover for the Upper Fields at the Williamson River Delta Preserve monitoring plots in 2000, 2001, and 2003. Values are % frequency and cover.

Species	Guild code	Freq $3m^2$ 2000	Freq $3m^2$ 2001	Freq $3m^2$ 2003	Freq $1m^2$ 2003	Avg. cover $1m^2$ 2003
Agrostis exarata	N,PW	0.00	0.00	6.35	3.17	0.00
Alisma plantago-aquatica	N,PW	3.17	0.00	1.59	0.00	0.00
Amaranthus albus	N,NW	0.00	0.00	1.59	0.00	0.00
Amaranthus powellii	N,NW	4.76	0.00	3.17	1.59	0.02
Amsinckia menziesii var. intermedia	N,NW	0.00	0.00	1.59	0.00	0.00
Annual forb	U	0.00	0.00	7.94	6.35	0.02
Avena sativa	E	1.59	1.59	0.00	0.00	0.00
Bidens cernua	N,AW	6.35	1.59	4.76	0.00	0.00
Bidens frondosa	N,AW	0.00	0.00	17.46	4.76	0.05
Brassica rapa	E	3.17	0.00	0.00	0.00	0.00
Bromus tectorum	E	0.00	0.00	1.59	1.59	0.00
Capsella bursa	E	0.00	3.17	0.00	0.00	0.00
Carex sp.	N,PW	3.17	0.00	0.00	0.00	0.00
Ceratophyllum dermersum	N,PW	1.59	0.00	0.00	0.00	0.00
Chamomilla suaveolens	E	1.59	1.59	0.00	0.00	0.00
Chenopodium album	E	33.33	30.16	77.78	50.79	19.28
Chenopodium atrovirens	N,NW	0.00	0.00	4.76	4.76	0.00
Chenopodium leptophyllum var. oblongifolium	N,NW	0.00	0.00	12.70	7.94	0.11
Cirsium arvense	E	0.00	0.00	4.76	1.59	0.00
Cirsium vulgare	E	1.59	12.70	7.94	3.17	0.67
Descurania Sophia	E	0.00	0.00	1.59	0.00	0.00
Echinochloa crus-galli	E	0.00	0.00	3.17	0.00	0.00
Eleocharis acicularis	N,PW	12.70	3.17	0.00	0.00	0.00
Eleocharis palustris	N,PW	0.00	0.00	12.70	11.11	0.51
Elodea Canadensis	N,PW	1.59	0.00	0.00	0.00	0.00
Elytrigia repens	E	57.14	31.75	41.27	36.51	10.66
Epilobium ciliatum ssp. watsonii	N,NW	0.00	0.00	20.63	7.94	0.13
Epilobium paniculatum	N,NW	0.00	0.00	3.17	1.59	0.08
Equisetum arvense	N,NW	1.59	0.00	1.59	1.59	0.24
Erigeron philadelphicus	N,NW	3.17	7.94	0.00	0.00	0.00
Erysimum cheiranthoides	E	0.00	0.00	3.17	0.00	0.00
Gnaphalium palustre	N,NW	7.94	6.35	14.29	14.29	1.67
Helianthus bolanderi	N,NW	1.59	0.00	0.00	0.00	0.00
Hippuris vulgaris	N,PW	1.59	0.00	1.59	1.59	0.05
Hordeum jubatum	N,NW	0.00	1.59	3.17	1.59	0.00
Juncus balticus	N,PW	11.11	0.00	0.00	0.00	0.00
Lactuca serriola	E	22.22	36.51	25.40	17.46	1.45
Lemna minor var. minima	N,PW	6.35	0.00	0.00	0.00	0.00
Matricaria maritime	E	0.00	0.00	1.59	1.59	0.00
Mentha arvensis	N,NW	0.00	0.00	3.17	0.00	0.00
Panicum capillare	N,NW	3.17	0.00	20.63	11.11	0.07
Poa secunda	N,NW	0.00	4.76	0.00	0.00	0.00
Polygonum aviculare	E	0.00	0.00	1.59	0.00	0.00
Polygonum lapathifolium	N,AW	0.00	0.00	9.52	6.35	0.03
Polygonum persicaria	E	11.11	9.52	28.57	19.05	0.62
Polypogon monspeliensis	E	4.76	3.17	12.70	9.52	0.01
Populus sp.	U	1.59	0.00	0.00	0.00	0.00

Table 6. (cont.)

Species	Guild code	Freq 3m^2 2000	Freq 3m^2 2001	Freq 3m^2 2003	Freq 1m^2 2003	Avg. cover 1m^2 2003
Potamogeton pectinatus	N,PW	4.76	0.00	0.00	0.00	0.00
Potentilla anserine	N,PW	0.00	0.00	3.17	0.00	0.00
Potentilla norvegica	N,NW	11.11	25.40	31.75	23.81	0.37
Ranunculus sceleratus	N,PW	7.94	0.00	6.35	4.76	0.38
Rorippa curvisiliqua	N,AW	0.00	0.00	7.94	6.35	0.03
Rorippa sp.	U	17.46	39.68	0.00	0.00	0.00
Rumex crispus	E	0.00	15.87	9.52	3.17	0.49
Rumex maritimus	N,AW	30.16	7.94	71.43	65.08	10.62
Sagittaria cuneata	N,PW	1.59	0.00	0.00	0.00	0.00
Salix lucida ssp. lasiandra	N,PW	3.17	0.00	0.00	0.00	0.00
Scirpus acutus	N,PW	41.27	26.98	36.51	19.05	6.16
Scirpus americanus	N,PW	0.00	0.00	1.59	0.00	0.00
Scirpus maritimus	N,PW	0.00	0.00	1.59	1.59	0.00
Sisymbrium altissimum	E	14.29	15.87	9.52	4.76	0.02
Solanum sarrachoides	N,NW	0.00	1.59	0.00	0.00	0.00
Sonchus asper	E	7.94	3.17	0.00	0.00	0.00
Typha latifolia	N,PW	14.29	7.94	15.87	14.29	0.62
Unk forb	U	1.59	0.00	0.00	0.00	0.00
Unknown	U	0.00	0.00	3.17	0.00	0.00
Urtica dioica	N,NW	0.00	3.17	3.17	3.17	0.16
Veronica anagallis-aquatica	N,PW	20.63	0.00	33.33	20.63	0.54
Guild summary						
native perennial wetland	N,PW	65.08	28.57	61.90	46.03	8.27
native annual wetland	N,AW	31.75	7.94	73.02	66.67	10.73
native non-wetland	N,NW	17.46	38.10	57.14	44.44	2.85
Exotic	E	65.08	80.95	88.89	76.19	33.21
Plot cover						
All plants						55.08
Bare ground						31.20
Litter						13.35
Water						0.00

Table 7. Plant species and guild frequencies and cover for Campfields at the Williamson River Delta Preserve monitoring plots for 2000-2004. Values are % frequency and cover.

Species	Guild Code	Freq 3m² 2000	Freq 3m² 2001	Freq 3m² 2002	Freq 3m² 2003	Freq 3m² 2004	Freq 1m² 2003	Freq 1m² 2004	Avg. cover 1m² 2003	Avg. cover 1m² 2004
Agrostis exarata	N,PW	0.00	0.00	1.56	4.69	3.13	1.56	0.00	0.06	0.00
Agrostis idahoensis	N,NW	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00
Alopecurus aequalis	N,PW	0.00	0.00	0.00	0.00	3.13	0.00	0.00	0.00	0.00
Alopecurus pratensis	E	9.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Amaranthus powellii	N,NW	17.19	3.13	4.69	9.38	0.00	3.13	0.00	0.06	0.00
Amsinckia menziesii var. intermedia	N,NW	1.56	1.56	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Annual forb	U	0.00	0.00	0.00	4.69	3.13	1.56	3.13	0.00	0.03
Artemisia biennis	N,AW	0.00	0.00	0.00	6.25	0.00	3.13	0.00	0.00	0.00
Avena sativa	E	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Bidens cernua	N,AW	31.25	29.69	29.69	21.88	0.00	17.19	0.00	0.23	0.00
Bidens frondosa	N,AW	0.00	0.00	0.00	40.63	18.75	26.56	10.94	5.46	0.35
Brassica rapa	E	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capsella bursa	E	0.00	9.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Carex angustata	N,PW	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00
Carex athrostachya	N,PW	0.00	0.00	0.00	1.56	0.00	1.56	0.00	0.03	0.00
Carex cusickii	N,PW	0.00	0.00	0.00	3.13	0.00	3.13	0.00	0.32	0.00
Carex sp.	N,PW	4.69	4.69	0.00	0.00	1.56	0.00	1.56	0.00	1.33
Ceratophyllum dermersum	N,PW	0.00	3.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chenopodium album	E	35.94	17.19	54.69	37.50	64.06	31.25	56.25	3.76	9.34
Chenopodium atrovirens	N,NW	0.00	0.00	0.00	4.69	0.00	3.13	0.00	0.04	0.00
Cirsium arvense	E	0.00	0.00	0.00	3.13	6.25	1.56	1.56	0.03	0.00
Cirsium sp.	E	0.00	0.00	0.00	3.13	0.00	1.56	0.00	0.00	0.00
Cirsium vulgare	E	3.13	1.56	0.00	3.13	9.38	1.56	6.25	0.31	0.60
Cyperus aristatus	N,AW	0.00	0.00	0.00	0.00	4.69	0.00	0.00	0.00	0.00
Eleocharis acicularis	N,PW	15.63	28.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Eleocharis palustris	N,PW	0.00	0.00	21.88	35.94	39.06	34.38	28.13	7.63	6.15
Elytrigia repens	E	32.81	35.94	3.13	25.00	10.94	14.06	6.25	3.51	4.06
Epilobium angustifolium	N,NW	0.00	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00
Epilobium ciliatum ssp. watsonii	N,NW	0.00	0.00	0.00	6.25	3.13	1.56	1.56	0.00	0.03
Epilobium paniculatum	N,NW	0.00	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00
Erigeron philadelphicus	N,NW	18.75	0.00	7.81	0.00	0.00	0.00	0.00	0.00	0.00
Galium aparine	N,NW	3.13	3.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gnaphalium palustre	N,NW	1.59	4.69	0.00	0.00	1.56	0.00	0.00	0.00	0.00
Gratiola neglecta	N,AW	0.00	0.00	0.00	0.00	1.56	0.00	1.56	0.00	0.01
Helianthus annus	N,NW	0.00	0.00	0.00	3.13	0.00	1.56	0.00	0.03	0.00
Helianthus bolanderi	N,NW	4.69	1.56	0.00	0.00	1.56	0.00	1.56	0.00	0.02
Hordeum jubatum	N,NW	3.13	4.69	1.56	4.69	6.25	3.13	3.13	0.86	0.59
Juncus balticus	N,PW	7.81	0.00	0.00	3.13	0.00	3.13	0.00	0.11	0.00
Lactuca serriola	E	14.06	6.25	6.25	4.69	4.69	4.69	3.13	0.22	0.01
Lemna minor var. minima	N,PW	0.00	1.56	0.00	12.50	7.81	10.94	7.81	0.77	0.25
Limosella aquatica	N,AW	0.00	0.00	0.00	0.00	3.13	0.00	1.56	0.00	0.00
Ludwigia palustris	N,PW	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Lycopus asper	N,PW	0.00	0.00	0.00	3.13	9.38	1.56	3.13	0.02	0.04
Medicago sativa	E	7.81	4.69	0.00	6.25	0.00	4.69	0.00	0.16	0.00

Table 7. (cont)

Species	Guild Code	Freq. 3m² 2000	Freq. 3m² 2001	Freq. 3m² 2002	Freq. 3m² 2003	Freq. 3m² 2004	Freq. 1m² 2003	Freq. 1m² 2004	Avg. cover 1m² 2003	Avg. cover 1m² 2004
Mentha arvensis	N,NW	10.94	4.69	0.00	18.75	14.06	9.38	3.13	0.17	0.08
Muhlenbergia filiformis	N,AW	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Myriophyllum sibiricum	N,PW	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Myriophyllum sp.	U	0.00	0.00	0.00	1.56	0.00	1.56	0.00	0.00	0.00
Panicum capillare	N,NW	25.00	14.06	10.94	15.63	6.25	9.38	3.13	0.38	0.02
Perennial grass	U	0.00	0.00	0.00	0.00	14.06	0.00	7.81	0.00	0.10
Phalaris arundinacea	E	1.56	1.56	3.13	1.56	0.00	0.00	0.00	0.00	0.00
Poa secunda	N,NW	4.69	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum amphibium	N,PW	0.00	0.00	1.56	23.44	21.88	12.50	15.63	4.06	6.88
Polygonum hydropiperoides	N,PW	0.00	0.00	3.13	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum lapathifolium	N,AW	0.00	0.00	4.69	7.81	6.25	3.13	4.69	0.08	0.13
Polygonum persicaria	E	26.56	20.31	0.00	9.38	15.63	6.25	9.38	1.64	2.92
Polypogon monspeliensis	E	0.00	10.94	4.69	4.69	7.81	4.69	6.25	0.04	0.16
Populus sp.	U	6.25	1.56	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Potamogeton crispus	E	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Potamogeton natans	N,PW	0.00	10.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Potamogeton pectinatus	N,PW	20.31	25.00	0.00	23.44	20.31	21.88	17.19	14.53	5.56
Potentilla anserina	N,PW	0.00	0.00	3.13	7.81	9.38	6.25	6.25	0.67	1.80
Potentilla norvegica	N,NW	0.00	0.00	0.00	3.13	0.00	1.56	0.00	0.05	0.00
Ranunculus aquatilis	N,PW	0.00	0.00	0.00	3.13	10.94	3.13	7.81	0.11	0.38
Ranunculus sceleratus	N,PW	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rorippa curvisiliqua	N,AW	0.00	0.00	1.56	7.81	31.25	7.81	25.00	0.56	6.38
Rorippa sp.	U	21.88	17.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rumex crispus	E	4.69	7.81	7.81	1.56	6.25	0.00	4.69	0.00	0.27
Rumex maritimus	N,AW	48.44	25.00	0.00	18.75	23.44	12.50	10.94	2.02	0.27
Rumex sp.	U	0.00	0.00	0.00	1.56	0.00	0.00	0.00	0.00	0.00
Salix geyeriana	N,PW	0.00	0.00	3.13	1.56	3.13	1.56	0.00	0.39	0.00
Salix lucida ssp. lasiandra	N,PW	37.50	34.38	18.75	37.50	37.50	17.19	18.75	6.67	11.48
Scirpus acutus	N,PW	28.13	20.31	17.19	26.56	32.81	18.75	23.44	6.66	12.29
Scirpus americanus	N,PW	0.00	0.00	4.69	1.56	0.00	1.56	0.00	0.06	0.00
Scirpus maritimus	N,PW	0.00	0.00	1.56	12.50	9.38	3.13	4.69	0.27	0.27
Sisymbrium altissimum	E	4.69	4.69	0.00	1.56	3.13	0.00	0.00	0.00	0.00
Smilacina sp.	U	0.00	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solanum dulcamara	E	0.00	0.00	0.00	14.06	17.19	10.94	10.94	0.40	1.16
Solanum sarrachoides	N,NW	1.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sonchus asper	E	6.25	9.38	0.00	3.13	1.56	1.56	0.00	0.00	0.00
Symphyotrichum frondosum	N,AW	0.00	0.00	0.00	10.94	3.13	6.25	1.56	0.28	0.00
Typha latifolia	N,PW	15.63	21.88	9.38	18.75	20.31	10.94	12.50	1.67	3.52
Unk forb	U	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unk grass	U	0.00	0.00	0.00	6.25	0.00	4.69	0.00	0.01	0.00
Urtica dioica	N,NW	7.81	4.69	3.13	7.81	15.63	6.25	14.06	1.49	0.93
Veronica anagallis-aquatica	N,PW	18.75	0.00	1.56	9.38	14.06	3.13	7.81	0.05	0.08
Guild summary										
native perennial wetland	N,PW	79.69	78.13	53.13	92.19	92.19	82.81	79.69	44.09	50.01
native annual wetland	N,AW	59.38	35.94	32.81	57.81	64.06	50.00	43.75	8.65	1.67

Table 7. (cont.)

Species	Guild Code	Freq. $3m^2$ 2000	Freq. $3m^2$ 2001	Freq. $3m^2$ 2002	Freq. $3m^2$ 2003	Freq. $3m^2$ 2004	Freq. $1m^2$ 2003	Freq. $1m^2$ 2004	Avg. cover $1m^2$ 2003	Avg. cover $1m^2$ 2004
native non-wetland	N,NW	43.75	28.13	25.00	39.06	34.38	28.13	21.88	3.08	7.14
exotic	E	64.06	53.13	62.50	59.38	79.69	51.56	70.31	10.07	18.52
Plot cover										
All plants	-	-	-	-	-	-	-	-	66.68	77.48
Bare ground	-	-	-	-	-	-	-	-	27.73	16.73
Litter	-	-	-	-	-	-	-	-	4.98	14.09
Water	-	-	-	-	-	-	-	-	9.69	2.44

Table 8. Plant species and guild frequencies and cover for Riverbend at the Williamson River Delta Preserve monitoring plots for 2002-2004. Values are % frequency and cover.

Species	Guild Code	Freq. $3m^2$ 2002	Freq. $3m^2$ 2003	Freq. $3m^2$ 2004	Freq. $1m^2$ 2003	Freq. $1m^2$ 2004	Avg. Cover $1m^2$ 2003	Avg. Cover $1m^2$ 2004
Agrostis exarata	N,PW	0.00	11.11	17.78	4.44	6.67	0.01	0.14
Agrostis scabra	N,NW	0.00	2.22	0.00	2.22	0.00	0.00	0.00
Agrostis stolonifera	N,NW	0.00	6.67	6.67	2.22	2.22	0.09	0.11
Alisma plantago-aquatica	N,PW	22.22	42.22	55.56	20.00	28.89	0.43	0.86
Alopecurus aequalis	N,PW	0.00	60.00	57.78	51.11	51.11	7.58	9.67
Amaranthus powellii	N,NW	6.67	0.00	2.22	0.00	0.00	0.00	0.00
Annual forb	U	0.00	11.11	11.11	8.89	4.44	0.01	0.00
Annual grass	U	0.00	0.00	2.22	0.00	2.22	0.00	0.00
Avena sativa	E	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Azolla mexicana	N,PW	0.00	0.00	22.22	0.00	13.33	0.00	0.60
Beckmannia syzigachne	N,AW	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Bidens cernua	N,AW	4.44	55.56	26.67	40.00	8.89	4.29	0.18
Bidens frondosa	N,AW	24.44	15.56	13.33	13.33	6.67	0.12	0.02
Bromus tectorum	E	4.44	4.44	6.67	2.22	6.67	2.16	2.46
Carex angustata	N,PW	0.00	2.22	0.00	2.22	0.00	0.02	0.00
Carex athrostachya	N,PW	0.00	4.44	0.00	2.22	0.00	0.00	0.00
Carex feta	N,PW	2.22	0.00	0.00	0.00	0.00	0.00	0.00
Carex sp.	N,PW	0.00	0.00	11.11	0.00	4.44	0.00	0.16
Ceratophyllum dermersum	N,PW	0.00	0.00	6.67	0.00	2.22	0.00	0.56
Chenopodium album	E	42.22	28.89	42.22	20.00	35.56	1.22	0.83
Chenopodium atrovirens	N,NW	0.00	4.44	0.00	4.44	0.00	0.12	0.00
Cirsium arvense	E	2.22	2.22	6.67	0.00	2.22	0.00	0.22
Cirsium vulgare	E	0.00	6.67	13.33	4.44	6.67	0.45	2.27
Conyza canadensis	N,NW	0.00	2.22	0.00	0.00	0.00	0.00	0.00
Cryptantha ambigua	N,NW	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Cryptantha sp.	U	0.00	4.44	0.00	4.44	0.00	0.01	0.00
Cyperus aristatus	N,AW	0.00	24.44	31.11	20.00	26.67	1.32	1.04
Echinochloa crus-galli	E	48.89	2.22	0.00	0.00	0.00	0.00	0.00
Elatine californica	N,AW	0.00	0.00	2.22	0.00	2.22	0.00	0.22
Elatine sp.	U	0.00	6.67	0.00	2.22	0.00	0.56	0.00
Eleocharis acicularis	N,PW	17.78	37.78	60.00	35.56	57.78	10.18	14.65
Eleocharis palustris	N,PW	26.67	75.56	73.33	55.56	64.44	9.59	20.49
Elodea canadensis	N,PW	6.67	4.44	11.11	4.44	11.11	2.00	6.22
Elytrigia repens	E	4.44	8.89	6.67	4.44	2.22	0.04	0.44
Epilobium angustifolium	N,NW	4.44	0.00	0.00	0.00	0.00	0.00	0.00
Epilobium ciliatum ssp. watsonii	N,NW	2.22	8.89	8.89	6.67	4.44	0.09	0.22
Epilobium paniculatum	N,NW	0.00	8.89	8.89	6.67	2.22	0.17	0.01
Equisetum arvense	N,NW	0.00	4.44	6.67	2.22	2.22	0.00	0.00
Erysimum cheiranthoides	E	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Euphorbia serpyllifolia	N,NW	0.00	2.22	0.00	2.22	0.00	0.02	0.00
Galium trifidum	N,PW	0.00	2.22	2.22	2.22	2.22	0.02	0.00
Gnaphalium palustre	N,NW	48.89	42.22	66.67	33.33	60.00	0.67	1.12
Gratiola neglecta	N,AW	0.00	11.11	6.67	6.67	4.44	0.02	0.01
Helenium autumnale	N,PW	0.00	2.22	0.00	0.00	0.00	0.00	0.00

Table 8. (cont.)

Species	Guild Code	Freq. 3m² 2002	Freq. 3m² 2003	Freq. 3m² 2004	Freq. 1m² 2003	Freq. 1m² 2004	Avg. Cover 1m² 2003	Avg. Cover 1m² 2004
Hordeum jubatum	N,NW	2.22	4.44	4.44	2.22	2.22	0.00	0.07
Juncus balticus	N,PW	0.00	4.44	0.00	4.44	0.00	0.38	0.00
Lactuca serriola	E	6.67	6.67	11.11	4.44	6.67	0.62	0.11
Lemna minor var. minima	N,PW	0.00	2.22	2.22	2.22	0.00	0.04	0.00
Limosella aquatica	N,AW	0.00	20.00	6.67	8.89	2.22	0.12	0.00
Lotus purshianus	N,NW	0.00	2.22	0.00	0.00	0.00	0.00	0.00
Ludwigia palustris	N,PW	0.00	13.33	17.78	13.33	11.11	0.34	0.05
Medicago sativa	E	0.00	0.00	11.11	0.00	8.89	0.00	0.64
Melilotus albus	E	0.00	4.44	0.00	2.22	0.00	0.04	0.00
Melilotus officinalis	E	2.22	2.22	2.22	2.22	2.22	0.09	0.56
Mentha arvensis	N,NW	0.00	6.67	11.11	2.22	4.44	0.00	0.09
Muhlenbergia filiformis	N,AW	0.00	2.22	6.67	0.00	0.00	0.00	0.00
Panicum capillare	N,NW	6.67	26.67	44.44	15.56	24.44	0.38	0.56
Perennial forb	U	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Perennial grass	U	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Phalaris arundinacea	E	8.89	26.67	33.33	8.89	13.33	1.02	1.32
Plantago major	N,NW	0.00	2.22	2.22	2.22	2.22	0.11	0.33
Poa pratensis	E	0	2.22	2.22	2.22	2.22	0.00	0.02
Polygonum amphibium	N,PW	2.22	2.22	0.00	0.00	0.00	0.00	0.00
Polygonum aviculare	E	15.56	48.89	35.56	40.00	28.89	3.88	4.31
Polygonum hydropiperoides	N,PW	8.89	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum lapathifolium	N,AW	6.67	22.22	24.44	8.89	15.56	0.02	0.04
Polygonum persicaria	E	2.22	11.11	13.33	4.44	4.44	0.38	0.89
Polypogon monspeliensis	E	0.00	2.22	2.22	0.00	2.22	0.00	0.00
Potamogeton crispus	E	0.00	2.22	0.00	2.22	0.00	0.11	0.00
Potamogeton pectinatus	N,PW	0.00	11.11	4.44	11.11	2.22	6.78	0.02
Potentilla anserina	N,PW	0.00	8.89	8.89	4.44	2.22	0.03	0.00
Potentilla norvegica	N,NW	0.00	4.44	6.67	0.00	4.44	0.00	0.01
Ranunculus cymbalaria	N,PW	0.00	0.00	2.22	0.00	0.00	0.00	0.00
Rorippa curvisiliqua	N,AW	8.89	20.00	33.33	15.56	31.11	0.03	0.31
Rumex crispus	E	28.89	0.00	2.22	0.00	0.00	0.00	0.00
Rumex maritimus	N,AW	0.00	35.56	33.33	26.67	17.78	1.94	0.50
Sagittaria cuneata	N,PW	6.67	33.33	35.56	20.00	17.78	1.68	1.29
Salix geyeriana	N,PW	17.78	37.78	51.11	22.22	22.22	1.00	0.82
Salix lucida ssp. lasiandra	N,PW	4.44	40.00	40.00	24.44	20.00	2.97	4.08
Scirpus acutus	N,PW	2.22	26.67	24.44	8.89	13.33	0.54	1.39
Scirpus maritimus	N,PW	0.00	8.89	6.67	4.44	0.00	0.02	0.00
Sisymbrium altissimum	E	0.00	4.44	0.00	2.22	0.00	0.09	0.00
Solanum dulcamara	E	0.00	0.00	4.44	0.00	0.00	0.00	0.00
Sonchus asper	E	0.00	4.44	2.22	0.00	0.00	0.00	0.00
Sparganium eurycarpum	N,PW	0.00	2.22	6.67	0.00	0.00	0.00	0.00
Symphyotrichum frondosum	N,AW	2.22	22.22	37.78	11.11	20.00	0.20	0.86
Trifolium repens	E	0.00	4.44	0.00	2.22	0.00	0.04	0.00
Typha latifolia	N,PW	0.00	13.33	11.11	4.44	0.00	0.01	0.00
Unk shrub	U	0.00	2.22	2.22	0.00	0.00	0.00	0.00
Urtica dioica	N,NW	2.22	8.89	6.67	6.67	4.44	0.05	0.29

Table 8. (cont.)

Species	Guild Code	Freq. $3m^2$ 2002	Freq. $3m^2$ 2003	Freq. $3m^2$ 2004	Freq. $1m^2$ 2003	Freq. $1m^2$ 2004	Avg. Cover $1m^2$ 2003	Avg. Cover $1m^2$ 2004
Verbascum thapsus	E	2.22	2.22	2.22	2.22	2.22	0.27	0.00
Veronica anagallis-aquatica	N,PW	13.33	4.44	4.44	2.22	4.44	0.00	0.36
Guild summary								
native, perennial wetland	N,PW	57.78	95.56	95.56	91.11	91.11	43.63	61.37
native, annual wetland	N,AW	44.44	75.56	77.78	62.22	68.89	8.06	3.19
native, non wetland	N,NW	57.78	57.78	77.78	48.89	73.33	1.71	2.82
exotic	E	80.00	82.22	80.00	68.89	71.11	10.42	14.10
Plot cover								
All plants	-	-	-	-	-	-	64.41	81.49
Bare ground	-	-	-	-	-	-	31.60	17.38
Litter	-	-	-	-	-	-	1.91	6.53
Water	-	-	-	-	-	-	8.76	0.09

Table 9. Plant species and guild frequencies and cover for South Marsh at the Williamson River Delta Preserve monitoring plots in 2002-2004. Values are % frequency and cover.

Species	Guild Code	Freq $3m^2$ 2002	Freq $3m^2$ 2003	Freq $3m^2$ 2004	Freq $1m^2$ 2003	Freq $1m^2$ 2004	Avg. Cover $1m^2$ 2003	Avg. Cover $1m^2$ 2004
Agrostis exarata	N,PW	7.50	7.50	0.00	7.50	0.00	2.08	0.00
Agrostis idahoensis	N,NW	7.50	0.00	0.00	0.00	0.00	0.00	0.00
Agrostis stolonifera	N,NW	0.00	2.50	0.00	2.50	0.00	0.88	0.00
Alopecurus aequalis	N,PW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Annual forb	U	0.00	5.00	2.50	5.00	0.00	0.06	0.00
Annual grass	U	0.00	0.00	2.50	0.00	2.50	0.00	0.00
Asteraceae sp.	U	2.50	0.00	0.00	0.00	0.00	0.00	0.00
Bidens frondosa	N,AW	0.00	2.50	2.50	0.00	2.50	0.00	0.03
Carex sp.	N,PW	0.00	5.00	5.00	2.50	2.50	0.01	0.00
Chenopodium album	E	37.50	82.50	42.50	72.50	35.00	10.74	5.25
Cirsium arvense	E	0.00	0.00	7.50	0.00	2.50	0.00	0.00
Cyperus aristatus	N,AW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Distichlis stricta	N,PW	0.00	12.50	12.50	10.00	12.50	3.10	4.33
Eleocharis palustris	N,PW	40.00	50.00	57.50	47.50	52.50	20.57	15.46
Elytrigia repens	E	5.00	5.00	2.50	2.50	2.50	2.45	0.63
Epilobium ciliatum ssp. watsonii	N,NW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Euphorbia serpyllifolia	N,NW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Hordeum jubatum	N,NW	10.00	12.50	0.00	0.00	0.00	0.00	0.00
Juncus balticus	N,PW	5.00	12.50	10.00	7.50	7.50	0.95	0.48
Lactuca serriola	E	0.00	2.50	0.00	0.00	0.00	0.00	0.00
Lemna minor var. minima	N,PW	0.00	2.50	22.50	2.50	17.50	0.03	0.03
Limosella aquatica	N,AW	0.00	0.00	7.50	0.00	5.00	0.00	0.28
Lolium arundinaceum	E	0.00	2.50	0.00	2.50	0.00	1.00	0.00
Melilotus officinalis	E	2.50	0.00	0.00	0.00	0.00	0.00	0.00
Panicum capillare	N,NW	2.50	5.00	5.00	2.50	2.50	0.00	0.00
Perennial grass	U	0.00	0.00	2.50	0.00	2.50	0.00	0.20
Phalaris arundinacea	E	12.50	22.50	10.00	7.50	7.50	0.94	1.63
Plantago major	N,NW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Poa pratensis	E	5.00	0.00	0.00	0.00	0.00	0.00	0.00
Poa secunda	N,NW	12.50	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum amphibium	N,PW	0.00	7.50	7.50	2.50	0.00	0.04	0.00
Potamogeton crispus	E	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Potamogeton pectinatus	N,PW	0.00	0.00	22.50	0.00	15.00	0.00	0.48
Potentilla anserina	N,PW	15.00	35.00	17.50	20.00	7.50	2.32	0.14
Puccinellia lemmonii	N,NW	0.00	2.50	0.00	2.50	0.00	2.35	0.00
Ranunculus aquatilis	N,PW	0.00	0.00	7.50	0.00	0.00	0.00	0.00
Rorippa curvisiliqua	N,AW	0.00	2.50	5.00	0.00	2.50	0.00	0.08
Rumex crispus	E	0.00	2.50	0.00	0.00	0.00	0.00	0.00
Rumex maritimus	N,AW	0.00	12.50	15.00	5.00	5.00	0.06	0.40
Sagittaria cuneata	N,PW	0.00	0.00	2.50	0.00	0.00	0.00	0.00
Scirpus acutus	N,PW	0.00	7.50	2.50	0.00	0.00	0.00	0.00
Scirpus americanus	N,PW	7.50	7.50	0.00	5.00	0.00	1.88	0.00
Scirpus maritimus	N,PW	0.00	10.00	10.00	5.00	2.50	0.09	0.04
Solanum dulcamara	E	0.00	0.00	2.50	0.00	2.50	0.00	0.01

Table 9. (cont.)

Species	Guild Code	Freq $3m^2$ 2002	Freq $3m^2$ 2003	Freq $3m^2$ 2004	Freq $1m^2$ 2003	Freq $1m^2$ 2004	Avg. Cover $1m^2$ 2003	Avg. Cover $1m^2$ 2004
Suaeda occidentalis	N,AW	0.00	2.50	0.00	0.00	0.00	0.00	0.00
Symphyotrichum frondosum	N,AW	17.50	40.00	10.00	20.00	5.00	0.98	0.18
Trifolium repens	E	0.00	0.00	5.00	0.00	0.00	0.00	0.00
Unk grass	U	0.00	2.50	0.00	2.50	0.00	0.01	0.00
Guild summary								
native perennial wetland	N,PW	52.50	72.50	75.00	70.00	70.00	31.05	20.94
native annual wetland	N,AW	17.50	42.50	22.50	25.00	15.00	1.04	0.95
native non-wetland	N,NW	22.50	20.00	7.50	7.50	2.50	3.23	0.00
exotic	E	50.00	90.00	47.50	80.00	37.50	15.13	7.52
Substrates								
All plants	-	-	-	-	-	-	50.53	29.61
Bare ground	-	-	-	-	-	-	45.70	25.80
Litter	-	-	-	-	-		0.95	11.78
Water	-	-	-	-	-	-	2.93	33.13

APPENDIX. Photos from the Williamson River Delta Preserve in 2003.

Figure A1. Emergent vegetation (*Hippuris vulgaris* and *Eleocharis palustris* in foreground, *Typha latifolia* and *Scirpus acutus* in background) in Field 5.

Figure A2. Vegetation monitoring plot (NP25) in North Pump Field dominated by *Rumex maritimus* and *Chenopodium album*.

Figure A3. Emergent vegetation at Riverbend with *Scirpus acutus* in foreground. (PS32 210' 9-23-03.JPG)

Figure A4. Emergent vegetation at South Pasture with *Eleocharis palustris* in foreground and *Scirpus acutus* in background. (WL3 102' 9-9-03r.JPG)