Five Year Summary Report
Martin Luther King, Jr. Regional Shoreline
Wetlands Project
Oakland, California

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1.0 Introduction

The Port of Oakland constructed the Martin Luther King, Jr. Regional Shoreline Wetlands Project (the Project) in 1998, with tidal action being restored on 10 June 1998. The site is located in San Leandro Bay, Oakland, California (Figure 1). The approximately 72-acre (29-hectare) Project site consists of three distinct restoration elements: tidal marsh, seasonal ponds, and uplands. These elements are shown in Figure 2. Figure 3 shows monitoring locations used during most or all of the project monitoring. A complete site description is presented in the Six-Month Monitoring Report (LFR 1999b).

Report purpose and organization. The purpose of this report is to summarize monitoring results from the first five years (from summer 1998 through summer 2003) following project construction in 1998, to evaluate project performance at the five-year mark relative to criteria contained in the Consent Decrees, and to identify the lessons learned from the project. This report is organized into the following sections:

- Aerial photography (Section 2)
- Hydrology and geomorphology (Section 3)
- Ecology (Section 4)
- Maintenance (Section 5)
- Project performance (Section 6)
- Compliance with Consent Decree requirements (Section 7)
- Major lessons learned (Section 8)
- Appendices incorporating vegetation lists (Appendix A), avian monitoring analysis (Appendix B), Save San Francisco Bay Association volunteer activities (Appendix C), and Golden Gate Audubon Society avian monitoring volunteers list (Appendix D).

This report does not repeat all the detailed monitoring data collected over the five-year period; refer to individual monitoring reports listed below for the complete data set.

Previous monitoring reports. Fifteen previous reports pertaining to project monitoring have been prepared for this project:

1. **Revised Preliminary Design Report** presents the project design which formed the basis for conditions to be monitored (LFR 1996).
2. **Monitoring and Maintenance Plan** (the “MMP”) presents the Project objectives, performance criteria, and monitoring protocols developed to assess Project progress (LFR 1999a).
3. **Six-Month Monitoring Report** presents the results of the first six months of monitoring, encompassing the period from introduction of tidal action through February 1999 (LFR 1999b). This report includes results from data collected on sediment accretion; tidal hydrology; channel morphology; seasonal pond depth and acreage; seasonal pond morphology; and bird use of the site.

4. **Year 1 (1998-1999) Monitoring Report** presents the first year's monitoring period of the Project Site (LES 1999). This report includes data collected on the vegetation colonization of the tidal, seasonal, and upland portions of the site and soil quality characteristics; and continued monitoring of sediment accretion, seasonal pond depth and acreage, and bird use of the site.
5. **Year 1 (1998-1999) Bird Use Report** presents results of bird monitoring conducted by the Golden Gate Audubon Society from October 1998 to April 1999 (HNEC 2000).
6. **Year 2 (1999-2000) Monitoring Report** presents the second year's monitoring period of the Project Site (WWR 2001). This report includes results from the continued monitoring of sediment accretion; tidal hydrology; channel morphology; seasonal pond depth and acreage; vegetation dynamics; and bird use.
7. **Year 2 (1999-2000) Bird Use Report** presents the results of bird monitoring conducted by the Golden Gate Audubon Society from August 1999 to April 2000 (HNEC 2001).
8. **Macroinvertebrate Study Year 2000** (Jones and Stokes 2000) presents results of benthic macroinvertebrate population monitoring performed by Jones and Stokes in May 2000.
9. **Year 3 (2000-2001) Monitoring Report presents results of the third monitoring year (WWR 2002a).** This report includes results from the continued monitoring of sediment accretion; tidal hydrology; channel morphology; seasonal pond depth and acreage; vegetation dynamics; and bird use.
9. **Year 3 (2000-2001) Bird Use Report** presents the results of bird monitoring conducted by the Golden Gate Audubon Society from August 2000 to April 2001 (HNEC 2002).
10. **Vegetation Monitoring Results** (Bishop O'Dowd High School 2001) present vegetation species and percent cover data collected by the Environmental Studies class at Bishop O'Dowd High School in April 2001.
11. **Year 4 (2001-2002) Monitoring Report presents results of the fourth monitoring year (WWR 2002b).** This report includes results from the continued monitoring of sediment accretion; tidal hydrology; channel morphology; seasonal pond depth and acreage; vegetation dynamics; and bird use.
12. **Year 4 (2001-2002) Bird Use Report** presents the results of bird monitoring conducted by the Golden Gate Audubon Society from August 2001 to April 2002 (HNEC 2003).
13. **Year 5 (2002-2003) Monitoring Report presents results of the fifth monitoring year (WWR 2003).** This report includes results from the continued monitoring of sediment accretion; tidal hydrology; channel morphology; seasonal pond depth and acreage; vegetation dynamics; and bird use.
14. **Year 5 (2002-2003) Bird Use Report** presents the results of bird monitoring conducted by the Golden Gate Audubon Society from August 2002 to April 2003 (HNEC 2003).

Monitoring Entities

- **EBRPD** directed monitoring, performed maintenance, and executed contracts for monitoring.
- **Port of Oakland** reviewed monitoring results and provided the underlying fiscal basis under the Consent Decree.
- **Golden Gate Audubon Society** monitored bird use throughout the monitoring period and reviewed monitoring results.
- **Lenington Ecological Services** conducted project monitoring (except birds) and reporting from Year ½ to 1.
- **Levine-Fricke-Recon** monitored from construction to Year ½ and prepared the project design and monitoring plan.
- **Wetlands and Water Resources** conducted project monitoring (except birds) and reporting for Years 2-5.
- **Henkel and Neuman Ecological Consulting** analyzed and reported on bird use data throughout the monitoring period.
- **Save San Francisco Bay Association** in collaboration with EBRPD developed and implemented community-based restoration activities beginning in Year 2.

2.0 Aerial Photography

A series of four aerial photographs have been taken since site restoration. The first aerial photograph of the series was flown on 25 September 2000 and is shown in Figure 4. The regional Invasive Spartina Project contracted for this photography as part of its larger effort to map the distribution and spread of the invasive *Spartina alterniflora* in the San Francisco Estuary; this site has been colonized by *S. alterniflora*. The 2000 photography was flown at a scale of 1:6,000, the San Francisco Estuary Institute (SFEI) rectified the photographs, and WWR created a mosaic image from the multiple photographs that encompassed the site. This project contracted for the second aerial photo (Figure 5), flown 24 July 2001 at a scale of 1:12,000 and rectified by WWR. The higher flight altitude allowed for a single image to cover the entire site, eliminating the need to mosaic multiple images. The Invasive Spartina Project flew the third photographs on 26 August 2002 at a scale of 1:6,000 (Figure 6). WWR rectified and created a mosaic image from the multiple photographs. This project contracted for the most recent photograph (Figure 7), flown on 29 August 2003 at a scale of 1:9,600 and rectified by WWR. The aerial photography was integral to monitoring a variety of processes in the Project, such as planform evolution and vegetation colonization. Details about how the photographs were used as a basis for monitoring can be found in the data analysis sections below and the prior monitoring reports.

Lessons learned on monitoring methods. Where aerial photographs are used to extract spatial data that will be compared between years for tidal marsh restoration (e.g., vegetation, geomorphology), maintaining similarity in image scale (or at least digitized pixel size) and photo timing optimizes the results and minimizes processing labor effort. For MLK monitoring, limited budgets mandated taking advantage of overlapping opportunities with other efforts. In this case, the Invasive Spartina Project's efforts to track *Spartina alterniflora* invasions provided two of four image sets and those images were flown to meet a larger set of monitoring objectives. The different scales and timing of photography ultimately impeded interannual comparisons and required additional labor effort to reduce that interference.

A second lesson is to establish permanent ground control to facilitate image rectification to yield quantitative data within years and the ability to overlay data between years accurately. In this case, no ground control had been used until the 2003 image, and horizontal positions of those points were measured with sub-meter GPS. A preferred approach would be to set permanent ground control (e.g., painted crosses on the ground) or place temporary control points for the monitoring duration.

3.0 Hydrology and Geomorphology

The monitoring plan (LFR 1999a) included seven hydrogeomorphic monitoring activities (Table 1). This section discusses six of these seven monitoring activities (the seventh is the aerial photography described in Section 2.0) and is organized in the following manner:

- Section 3.1, Channel network (this section combines the previously separate cross section and planform morphology monitoring)
- Section 3.2, Tidal inundation
- Section 3.3, Sediment accretion
- Section 3.4, Channel velocity, turbidity, and water quality
- Section 3.5, Seasonal pond depth and acreage

3.1 Channel Network

The constructed network of channels at the site serves a critical function by transporting the tides into and out of the site. The channels therefore serve both ecological and hydrogeomorphic functions. The design of the tidal channel network intended to provide full, unimpeded tidal exchange at project outset. Evaluating the evolution of these features is an important component of the monitoring program. Monitoring of channel morphology is presented in Section 2.6 of the Monitoring and Maintenance Plan (LFR 1999a).

3.1.1 Cross Sectional Morphology

Methods. To assess changes in channel cross section morphology, the MMP calls for annual topographic surveys at established cross sections. Five cross sections were established at the site: two at first-order channels, two at second order channels, and one at a third-order channel (just inside the breach). During annual field surveys, each cross section was surveyed into the permanent benchmark provided by the Port of Oakland near the breach at the north end of the site. Details of cross sectional morphology methods can be found in prior monitoring reports.

Results and Discussion. Figure 3 shows the cross section locations. Figure 8 shows the two first-order channel cross sections, Figure 9 shows the two second-order channel cross sections, and Figure 10 shows the single third-order cross section. These figures plot all cross section survey data collected during the five-year monitoring. Data collected in 1998 (LFR 1999b) and 1999 (LES 1999), prior to WWR carrying out the monitoring activities, could not be verified for their vertical and horizontal control; we have attempted to resolve uncertainties and have noted in the figures where problems were encountered.

All cross sections plot data from “left bank” to “right bank” with ebb tide representing the flow direction. Thus, each cross section is looking “downstream” toward the open bay, consistent with plotting terrestrial stream cross sections. All cross sections plot data with matching horizontal and vertical scales so that relative channel sizes are visually evident between cross sections.

In general, the topographic data for all five monitored channels indicate little to no significant change occurred in channel size, morphology, or position within the past five years. XS-1W, XS-1E, and XS-2W experienced a slight accretion of sediment (see Figures 8 and 9), while XS-2E and XS-3 demonstrated a slight scouring of the thalweg (see Figures 9 and 10). These minor changes in morphology over the past five years suggest one of three conditions for the channel network as constructed: (1) it was constructed at an appropriate size for the tidal prism at the site, (2) if undersized, it could not erode due to the hard substrate at the site, or (3) changes may be at slow rates undetectable by the monitoring method over a five-year period. The tidal exchange data presented below in Section 3.2 indicate unimpeded tidal exchange, suggesting that the channels were appropriately sized at the outset.

3.1.2 Planform Morphology

Methods. Lateral migration of a channel occurs by bank erosion and accretion. Monitoring channel planform migration can occur through field topographic cross section surveys as described in Section 3.1.1 and through rectified time series aerial photography described in Section 2.0.

Results via cross sections. All five cross sections exhibited little if any lateral migration (Figures 8, 9 and 10). XS-2E and XS-3 show a slight widening of the channel, on the order of a few feet, with channel top widths roughly 20 and 27 feet, respectively.

Results via aerial photography. There is no air photograph taken shortly after construction, so we elected to use a digitized and rectified version of the restoration design drawing from LFR (1999a) (Figure 2); this baseline is an approximate representation of as-built conditions. Comparing this baseline channel network configuration to the 2003 photograph (Figure 11), from a qualitative perspective the channels were constructed as designed and have remained stable with minimal lateral movement and headward expansion or retreat. The channel cross sections shown in Figures 8 through 10 confirm this observation.

Field observations indicate that small channels are beginning to form in several places on the marsh plain. These channels are small, generally less than 0.3 m (1 ft) wide. These channels appear to drain partially the areas that pond at low tide, which are generally evident in the aerial photograph as the darkest areas on the marsh plain. These small channels are not yet distinct enough for capture via remote sensing techniques.

3.1.3 Lessons Learned

Lessons learned on monitoring methods. Prior to initiating monitoring activities, horizontal and vertical control need to be established, documented, and effectively monumented in the field so that all cross section surveys over time are repeated precisely and therefore can be overlaid quantitatively.

Lessons learned on channel network design. The MLK design was based on the as-built tidal prism and, based on the data presented here and that in the next section on tidal inundation, indicate that they were appropriately sized at construction.

3.2 Tidal Hydrology

With any restoration project, tidal inundation is vital to the successful formation of intertidal marsh. The tides carry sediment, nutrients, fish, plant seeds and seedlings, plankton, and detritus into and out of the marsh, helping to establish the role of the tidal wetland as a component of the bay ecosystem. Tides in the San Francisco Estuary are mixed semidiurnal, or twice-daily tides of unequal height with a meso-tidal range of roughly 6 ft (2 m) at the Golden Gate amplifying to roughly 9 ft (3 m) in the South Bay; spring tidal range at the nearby Alameda NOS station is amplified 0.75 ft (0.23 m).

The MLK site has two separate tidal wetland types – tidal marsh and intertidal pond. All wetlands are defined in large part by their hydrology – the frequency, duration, and depth of inundation, or hydroperiod (Mitsch and Gosselink 2000). Their hydrology in turn depends on water source(s), flow characteristics, and wetland geomorphology including distributary channels. Tidal marsh hydrology consists of high frequency, short duration, generally shallow events and exposed marsh plain between high tides (i.e., twice daily wetting and exposure). Intertidal pond hydrology, in contrast, consists of low frequency, long duration, shallow events (i.e., generally wet) overlaid by high frequency, short duration, shallow high tides (i.e., daily fluctuating shallow depths), with no exposed pond bottom. Low water pond depth at ebb tide is set by constructed elevations at the Project, at about 5.6 ft Port Datum.

3.2.1 Methods

We monitored tidal inundation at two locations with data logging pressure transducers: (1) near the headward reach of the eastern first-order channel, at cross section 1E, and (2) within the intertidal pond. Monitoring took place three times: January 2001 (Figure 12), July-August 2001 (Figure 13), and June-July 2003 (Figure 14). We also downloaded tides for the nearby National Ocean Service continuous recording station in Alameda (NOS Station 941-4750) and plotted alongside site data for comparison. Details about tidal inundation monitoring methods and results can be found in the prior monitoring reports.

3.2.2 Results and Discussion

These monitoring data yield three outcomes. First, the height of high tides and the daily rise and fall of the tide "wave" within the site matched the Alameda reference tides closely, within about 0.2 ft or less and a uniform lag time of about 1.5 hours, indicating unimpeded tidal exchange throughout the site. Second, the tide heights remained relatively constant between monitoring periods, indicating that unimpeded tidal exchange has occurred since initial monitoring in 2000 (and likely since restoration) and is functioning effectively and as designed. Third, the Intertidal Pond lower tide levels fluctuated up to 0.25 ft during some of the periods monitored, indicating that the amount of pond drainage varies over time with no pattern detectable in the data (Figures 12 to 14). EBRPD repaired a small breach in the pond berm in 2001 that had been open for roughly one year.

3.2.3 Lessons Learned

Tidal exchange has worked effectively and as designed at this project. The monitoring results indicate that the channel network geometry was properly sized. The monitoring itself yielded data effective for evaluating this performance criterion.

3.3 Sediment Accretion

Section 2.3 of the MMP (LFR 1999a) requires annual sediment accretion monitoring. Sediment accretion is a very important process for tidal wetlands in general and for Project success at this site. The project design incorporated marsh surface elevations lower than that of reference sites to facilitate accretion of natural sediments in order to provide a better substrate for salt marsh vegetation establishment.

The project design (LFR 1996) estimated sedimentation rates for the project site using nomographs developed by the San Francisco Estuary Institute (Collins 1994). The predicted sedimentation rate for high marsh areas was calculated to be 0.006 ft/yr or 0.002 m/yr. The predicted sedimentation rate for low-marsh areas was calculated to be 0.05 ft/yr or 0.015 m/yr. The estimated sedimentation periods were considered conservative estimates and were expected to be slightly higher once the site is vegetated. Details about these predictions can be found in prior monitoring reports.

3.3.1 Methods

Through monitoring year three (2001), monitoring relied upon fixed sediment pins measured annually to document sedimentation rates at the site. The data obtained through this method proved to be unreliable for a number of reasons: insensitivity of the method relative to the small quantities of sediment accumulation; human disturbance to the sediment pins and/or the immediately surrounding ground surface; and measurement of incorrect PVC marker due to lack of labeling when installed during project construction combined with very large numbers of PVC markers installed by a variety of entities for multiple purposes. For the 2001-2002 and 2002-2003 monitoring periods, we used an alternative approach to estimate sediment accretion: utilizing data from channel topographic cross sections that covered 15-35 ft of marsh plain adjacent to the channels (see Figures 8 to 10). Vertical accuracy of each cross section is fairly high (±0.02 m) and depends largely upon the surveyor holding the rod carefully at the ground surface. However, since the cross section surveys did not have a stated intention to quantify sediment accretion, we cannot know for sure whether the exact path was reoccupied from year to year. This unknown introduces a between-year comparative uncertainty of perhaps ±0.03 m but potentially more. Therefore, we must limit our interpretation of quantitative results to a qualitative assessment. We have used the five cross sections in this report to provide estimates of tidal marsh accretion rates.

3.3.2 Results and Discussion

Sediment Pin Sedimentation Data. Table 2 presents the limited sediment pin data that we presume to be valid. Sedimentation rates in the seasonal wetlands (5 sediment pins) varied from -0.035 to 0.025 m/yr. Rates in the high tidal marsh (3 sediment pins) varied from 0.006 to 0.038 m/yr; these rates exceed the predicted 0.002 m/yr. No data are available for the low tidal marsh areas.

Cross Section Sedimentation Data. Table 3 shows the sediment accretion estimates derived from the topographic survey data. Over the two-year period in which we used this coarse method, accretion rates ranged from -0.01 to 0.02 m/yr and -0.02 to 0.04 m/yr in low and high marsh, respectively, ±0.03 m/yr. In other words, there are no statistically significant differences between years. To the extent that these rates are valid given the coarse nature of the field method for this purpose, they suggest that where accretion is occurring, its rates reasonably reflect if not exceed predictions.

Conclusions. In spite of the limited results from the quantitative approach, qualitative field observations clearly show a thin layer of mud deposited over the constructed marsh plain surface, establishing that deposition is occurring throughout most if not all of the tidal portions at the MLK site. Given the low predicted rates, it is reasonable to conclude that accretion is meeting or exceeding the predictions.

3.3.3 Lessons Learned

Monitoring strategies. Sedimentation monitoring at sites with low predicted rates combined with comparatively high human activity on the marsh plain requires a more sensitive technique than the sedimentation pins or cross section topography used at MLK. A simple method may be the most useful approach, though it has the potential to introduce measurement bias: walk around the marsh plain pushing a measuring stick into mud and measuring depth to the underlying hard surface. Such a strategy might work at MLK due to the hard underlying substrate remnant from the site's prior fill. The most effective yet more costly approach is to install and measure periodically Sediment Elevation Tables (SETs).

Project design. Restoration projects constructed from upland excavation such as MLK are always faced with the questions of how far down to grade and how rapidly will natural sedimentation build marsh plain elevations to target heights. Thicker deposited mud provides a more natural substrate for plant growth and invertebrate community establishment, pushing for a lower constructed elevation. Lower sediment supply such as at MLK translates into longer times for that natural accretion, thereby slowing down the restoration process. It is difficult to say whether the MLK design struck the right balance yet it is reasonable to conclude that the design is progressing as predicted. More time is needed to allow the site to evolve and more and different monitoring would have to be conducted to address this design question more thoroughly. Further, interim conditions periodically provide significant albeit ephemeral ecological benefits.

3.4 Channel Velocity, Turbidity, and Water Quality

The velocity and turbidity of the tidal waters that flood and drain the site are indicative of the physical processes within a tidal marsh that are responsible for sediment accumulation on the marsh plain and channel network development. These measurements are useful diagnostics if problems develop in tidal marsh physical evolution. Section 2.6 of the MMP (LFR 1999a) requires velocity and turbidity monitoring. Velocity and turbidity measurements were made during 1998-1999 (LFR 1999b), 1999-2000 (WWR 2001), and 2000-2001 (WWR 2002). Water quality indicators of pH, dissolved oxygen, conductivity, and redox potential can be helpful to evaluate marsh chemical and biological processes. The MMP did not require water quality monitoring; we performed this testing during 2000-2001 only when we had the instruments for separate EBRPD tidal marsh restoration monitoring at Oro Loma Marsh in Hayward (WWR 2002c). Figure 15 displays the tidal cycle present when velocity and turbidity was sampled in 1999, 2000, and 2001.

3.4.1 Methods

Sampling took place at one or more channel cross section locations. Velocities were measured with a hand-held velocity meter placed either at mid-depth or at multiple depths. Turbidity, dissolved oxygen, pH, conductivity, and redox were measured with a hand-held in-situ meter calibrated by the equipment rental company; the sensor probe was placed either at mid-depth or at multiple depths.

3.4.2 Results and Discussion

For the three sampling periods in years 1 through 3, channel velocities ranged between 0.30 to 1.37 m/s at the five cross section locations, with the more bayward locations having higher velocities. These values are within the range expected for a tidal marsh and they depend on tide stage, tide direction, and spring vs. neap tide period. Turbidity during these sampling periods ranged between 2.8 to 41.5 NTU with no spatial patterns. These values indicate relatively low sediment supply, as anticipated during project design.

Water quality for the single event on the afternoon of August 24, 2001 yielded results for temperature of 22.8 to 25.5 degrees Celsius, pH of 7.75 to 7.88, dissolved oxygen (DO) of 4.89 to 5.87 mg/l, conductivity of 47.5 to 48.1 mS/cm, and redox of 114 to 128 mV. Of these water quality data, only DO data suggest any concern; the Regional Water Quality Control Board standard for DO is minimum 5.0 mg/l (SFBRWQCB 1995).

Full data are presented in the prior monitoring reports.

Many of these parameters fluctuate based on a number of externally-driven cycles, such as tidal stage, range of tides each day, season, extent of sunlight, and so forth. The comprehensive testing of these parameters necessary to provide data for evaluating potential marsh evolution problems was beyond the scope of the monitoring program. Single-event, once per year monitoring of these parameters can provide only limited interpretive value at best. Data that were collected, except for the non-required dissolved oxygen, did not reveal any unusual conditions. The single-event DO reading was only slightly below the RWQCB standard at 2 of 5 locations and could have been due to a number of internal or external factors. Monitoring of these parameters ceased after the third monitoring year for two reasons: first, they showed no adverse conditions warranting any corrective action; and second, the monitoring intensity was too limited to provide any information about marsh conditions.

3.5 Seasonal Pond Depth and Acreage

The seasonal ponds constructed in the southern portion of the Site were designed primarily as habitat for shorebirds. There are three ponds filled by rainfall captured by small drainage basins (Figure 3). To minimize water percolating into the soil and thereby draining the ponds, construction included covering the pond basins with Bay muds excavated from the Project Site. Section 2.4 of the MMP (LFR 1999a) requires monitoring pond depth and acreage.

3.5.1 Methods

Pond depth and acreage were monitored four times during the wet seasons of the first four monitoring years, and five times during the wet season of the final monitoring year. Pond depths were determined by reading water levels on staff gauges installed in the seasonal ponds. Pond acreages were determined by walking the pond perimeters with a handheld GPS unit that recorded position once every three seconds and calculating the area of the polygon. EBRPD staff handled the data download and acreage calculations. As the data set became large, we developed a stage-area relationship for each pond (Figure 16) and used it to estimate pond areas for some later monitoring efforts. Rainfall totals for each water year are obtained on the Internet from the California Department of Water Resources Division of Flood Management (http://cdec.water.ca.gov) for a station in the Oakland hills.

3.5.2 Results and Discussion

Table 4 presents the pond acreage and depth data from late 1998 through mid-2003 and Table 5 presents the monthly rainfall totals for the 1998-1999, 1999-2000, 2000-2001, 2001-2002, and 2002-2003 water years (California water years run from October 1 to the following September 30).

Based on field measurements and values predicted from the stage-area curve, all three seasonal ponds held water very well during each monitoring period. During the peak of each period's wet season, total pond acreage always exceeded the performance criterion of 4.5 acres with total acreage reaching up to almost 15 acres. Water levels exceeding the target range are beneficial because they translate into far larger surface area and, combined with the gradual pond slopes, provide a large area of desired water levels and longer pond persistence.

4.0 Ecology

The underlying purpose of the tidal and seasonal wetland restoration at MLK is to provide ecological support functions for species that depend upon these systems for part or all of their life cycles. The Monitoring and Maintenance Plan (LFR 1999a) presents the criteria for evaluating whether this purpose is achieved and the biological monitoring activities to gather data for evaluating performance. Wetlands and Water Resources and its predecessor, Lenington Ecological Services, carried out all monitoring except for bird use; the Golden Gate Audubon Society (GGAS) monitors bird use and Henkel-Neuman Ecological Consulting analyzes these data. This section is organized in the following manner:

- Section 4.1, Vegetation
- Section 4.2, *Spartina foliosa* transplants
- Section 4.3, Weed invasion
- Section 4.4, Loafing island vegetation
- Section 4.5, Bird use

4.1 Vegetation

The restored tidal marsh portion of the site is expected to support three habitat zones typical of San Francisco Bay marshes, including a narrow upper zone of peripheral halophytes at the site edge, a middle zone of perennial pickleweed (*Salicornia virginica*), and a lower zone of Pacific cordgrass (*Spartina foliosa*). In the long term, the intertidal plant community at the site should be comparable with those found at reference tidal marshes in the vicinity. The restored seasonal wetlands and ponds portion of the site is expected to support vegetation cover of less than 20 percent in the pond bottoms and at least 80 percent across two-thirds of the area and between 20 and 80 percent on the remaining one-third. Additionally, no large patches of invasive species should be present.

4.1.1 Methods

Vegetation was monitored through a combination of transect sampling and aerial photography. Details about the monitoring methods can be found in prior monitoring reports. In summary, in the tidal marsh we established five permanent transects once enough vegetation had established and in the seasonal ponds and wetlands we established six permanent transects, two per pond for the three ponds, extending from the pond center outward to the drainage divides between each pond. Along these transects we measured species composition, cover, and height once annually, in the summer for tidal marsh and in spring for the seasonal wetlands. Additionally for the tidal marsh, we obtained a new aerial photograph each year and used image analysis software to develop a vegetation map which we field-checked to produce a final map for each year.

4.1.2 Results and Discussion - Tidal Marsh

Table 6 presents the tidal marsh transect data, and Appendix A provides the species list. Eleven species typical to San Francisco Estuary tidal salt marshes can be observed along the five tidal marsh transects. Annual pickleweed (*Salicornia europaea*) colonized early throughout the site and it continues to dominate the tidal marsh vegetation. Also observed on transects and during vegetation map ground-truthing were perennial pickleweed (*S. virginica*), salt grass (*Distichlis spicata*), invasive smooth cordgrass (*Spartina alterniflora*), hybrids with *S. foliosa*, and possibly some of the native Pacific cordgrass (*Spartina foliosa*), brass buttons (*Cotula coronopifolia*), salt-marsh arrow-grass (*Triglochin cocinna*), alkali bulrush (*Scirpus maritimus*), sand-spurry (*Spergularia marina*), marsh gum-plant (*Grindelia stricta*), fleshy jaumea (*Jaumea carnosa*), and alkali heath (*Frankenia salina*), can also be observed along the measured transects. Below are some basic patterns of vegetation colonization at the site as evidenced by the field data (Table 6), the vegetation maps (Figures 17, 18, and 19), and the data summarized from the vegetation maps:

- There is greater vegetation colonization near to the tidal source (the north end of the site) than there is farthest from the tidal source.

- There is a relatively narrow "ring" of vegetation along the marsh/upland edge comprising a more mixed species composition and nearer to the tidal source. Save the Bay conducted extensive plantings in these areas (see App. C for more details).

- Vegetation now dominates the site overall, though bare ground still dominates at the southern end of the site farthest from the tidal source. During 2003, vegetation cover along the five field transects ranged between 26 and 95 percent, up from 11 to 74 percent in 2002, 2 to 53 percent in 2001, and 2 to 34 percent in 2000 (see Figure 20).

- The bare ground areas are often covered with algae mats and/or standing water at low tide.

- The dominant plant species at the site remains annual pickleweed *(Salicornia europaea).*

Overall Progress of Marsh Vegetation Colonization. The field transect and vegetation map data support the conclusion that the site has met its five-year performance criteria of 50% cover in high marsh and progress toward 50% cover in low marsh (see Figures 17, 18, and 19). There are two concerns in meeting these performance criteria. The first and major concern is colonization by smooth cordgrass, *Spartina alterniflora* and its hybrids with the native cordgrass. The project design anticipated this problem and the site is now included as one of the target sites for the regional Invasive Spartina Project. From the very limited occurrence of *S. alterniflora* in 2002, it appears that these control efforts are positively affecting the site. The second and probably not significant concern is the dominance of annual pickleweed (*Salicornia europaea*) in place of the perennial pickleweed (*Salicornia virginica*). Though the project design and performance criteria did not contemplate the annual variety, other restoration projects (e.g., Muzzi Marsh, built in 1976 in Marin County) had the annual species grow initially, replaced gradually by the perennial species (Phyllis Faber, pers. comm. 2003). Annual pickleweed is a native yet uncommon species and the ecological functions of pickleweed are generally reported in the context of the perennial species due to its major dominance. At present, there is no basis to identify annual pickleweed colonization as a concern, and perennial pickleweed is present at the site and appears to be increasing in cover at least in the high marsh where it is primarily expected.

Invasive *Spartina alterniflora* expansion at year 6, following monitoring completion. This monitoring report summarizes results of the Consent Decree-mandated five-year monitoring period, at the end of which *S. alterniflora* invasion had occurred yet had not progressed to more than perhaps 5% cover. In 2004, six years after construction and one year after monitoring ceased, *S. alterniflora* cover increased significantly, likely beyond 25% cover as determined from coarse visual estimates at the end of summer 2004. This significant shift in conditions following monitoring completion indicates that a five-year monitoring period does not yield a "final" outcome view. A lower frequency, longer duration monitoring program may provide a more meaningful view of project outcome.

4.1.3 Results and Discussion – Seasonal Wetlands and Ponds

Table 7 presents the vegetation transect data for the seasonal ponds, Table 8 summarizes vegetation percent cover outside the ponds, and Appendix A presents a complete list of vegetation species observed at the site. The most common species observed by 2003 were eight non-native species – cutleaf plantain (*Plantago coronopus*), prickle grass (*Crypsis vaginiflora*), Birdfoot trefoil (*Lotus corniculatus*), sour clover (*Melilotus indica*), Mediterranean Barley (*Hordeum marinum gussoneanum*), Brass Buttons (*Cotula coronopifolia*), Annual Ryegrass (*Lolium multiflorum*), and loosestrife (*Lythrum hyssopifolium*) – and one native species – California Barley (*Hordeum brachyantherum*).

Not encountered along the established transects but present sporadically within the seasonal ponds are stands of bulrush (*Scirpus maritimus*). These stands are fairly low density and all exhibit grazing pressure (possibly from Canada geese).

4.2 Spartina foliosa *Transplants*

Tracking success of *Spartina foliosa* transplants planted early in the restoration proved infeasible due to the invasive *S. alterniflora*. Early in the monitoring period the transplants were no longer distinctly present. It was not clear if the transplants failed, early *S. alterniflora* control efforts removed the transplants, or hybridization occurred and overtook the transplants. Consequently, tracking the results of the transplant experiment is no longer possible.

4.3 Other Weed Invasions

Weed invasion within the tidal marsh area is largely restricted to marsh upland edges and appears minimal. In the seasonal wetland area (Pond 2) several invasive species were observed. These include French broom (*Genista monspessulana*), sweet fennel (*Foeniculum vulgare*), peppergrass (*Lepidium latifolium*), pampas grass (*Cortaderia jubata*), yellow star thistle (*Centaurea solstitialis*), bristly oxtongue (*Picris echioides*), and *Salsola soda*. None of these species was present in dense patches and these species were largely restricted to the southern end of the site near the fence line. EBRPD staff managed invasive vegetation, with some assistance from volunteers. Most of the work was done by hand.

4.4 Loafing Island Vegetation

Vegetation on the loafing islands is minimal and mostly restricted to the edge and base of each island. No tall vegetation is present on the islands, which is consistent with the project goal of maintaining an unobstructed view for resting shorebirds on these islands. Perennial pickleweed (*Salicornia virginica*) and annual pickleweed *(Salicornia europaea)* appear on the edges of the islands. EBRPD did not perform any vegetation removal/maintenance on the loafing islands over the 5-year monitoring period. Island A shows slightly greater vegetation growth than Island B (see Figure 19).

4.5 Summary of 5-Year Waterbird Use

From October to April throughout the five-year monitoring period, GGAS volunteers monitored waterbird use at MLK and at two nearby reference sites (the Eastern and Western Reference Sites, see Figure 1). Following each monitoring period, GGAs volunteers provided the updated database to Henkel-Neuman Ecological Services, which analyzed these data for use results and trends and prepared an appendix to each year's monitoring report. Appendix C of this report presents their 5-year summary; the following material summarizes the lay findings.

Over the five years of this study, the Restoration Sites provided valuable foraging and roosting habitats for many species of waterbirds, particularly at rising and high tides. Within the Restoration Sites, species diversity increased slightly over the five-year study period. The average number of waterbird species observed per year was 36 at the Seasonal Ponds and 45 at the Tidal Wetlands compared to an average of 56 species at the Eastern Reference Site and 53 species at the Western Reference Site. Of 22 common shorebird species recorded in San Francisco Bay-wide surveys, all but three (spotted sandpiper *Actitis macularia*, snowy plover *Charadrius alexandrinus*, and red-necked phalarope *Phalaropus lobatus*) were recorded at the Restoration Sites in this study.

Habitat within the Tidal Wetlands became more vegetated over the five monitoring years of this study (Section 4.1 above), but in every year the Tidal Wetlands supported many more shorebirds than any other portion of the study site. Furthermore, the Tidal Wetlands supported shorebird densities that were similar to natural wetlands; mean shorebird abundance at the Tidal Wetlands was about 45 birds/ha, within the range of spring and fall densities reported for San Francisco Bay. Within the Tidal Wetlands, the two most important design features for shorebirds were the Marsh Plain and the Intertidal Pond. The Marsh Plain supported the most shorebirds and the Intertidal Pond supported the second greatest number of shorebirds. However, the Marsh Plain is significantly larger than any other habitat feature and the difference in relative size between this and other sub-areas may account for the differences in shorebird abundance. Shorebird abundance at the Seasonal Ponds increased over the course of this study, possibly due to generally greater pond depths that provide a greater linear area for foraging or safe loafing.

Seasonal abundance of shorebirds at the Reference and Restoration Sites varied with species composition: at the Tidal Wetlands, small sandpipers of the genus *Calidris* were dominant, and abundance peaked during migration periods; at all other sites, larger shorebirds were dominant, and abundance peaked during winter and spring. Shorebird abundance was lowest at all sites at low tide, indicating that shorebirds moved out of the study area at low tide to forage elsewhere in the region. All sites provided important high-tide roosting habitat for shorebirds. Within the Restoration Sites, important high-tide roosting sites included Islands A and B, the Intertidal Pond, and the Seasonal Ponds.

Table 9 summarizes the relative use of the restored habitat sub-areas by shorebirds. Within the Tidal Wetlands the areas that received the most use (as indicated by average abundance) were the Marsh Plain and the Intertidal Pond. These two areas supported significant numbers of shorebirds at all tidal stages except low tide. The loafing islands (Islands A and B) and the Seasonal Ponds were most important as high tide roost areas. The Channels received some use by shorebirds, but were probably most important for inundation of other sub-areas.

Seasonal abundance of waterfowl peaked at all sites during winter, a pattern which is similar to bay-wide patterns of waterfowl abundance. The Restoration and Reference Sites supported different waterfowl communities; most waterfowl at Restoration Sites were diving ducks (e.g., Scaup) but most waterfowl at Reference Sites were dabbling ducks (e.g., American Wigeon). Waterfowl use at the Seasonal Ponds was similar at all tidal stages, suggesting water fowl use was independent of the tides external to the site. In contrast, waterfowl used the Tidal Wetlands primarily during high and outgoing tides, probably because water levels during other tides were insufficient.

Clapper Rails were recorded in the adjacent Arrowhead Marsh reference site in all monitoring years, but were not yet seen in the Restoration Sites. Additional years of marsh development will probably be necessary before vegetation in the Tidal Wetlands provides enough cover for rails, and detection of rails in the Restoration Site may be limited by weather and inaccessibility. *S. alterniflora* invasion could affect whether Rail colonization occurs at all. Burrowing Owls were recorded in all monitoring years except 1998-1999, but were confirmed breeding only during spring/summer 2001. Destruction and occupation of the constructed burrowing owl nest chambers by ground squirrels may have inhibited the rate of burrow occupancy by nesting owls. EBRPD has begun to rebuild these nest chambers and expects to finish rebuilding them all soon.

Bird communities were compared among years and among sites using the Percent Similarity Index (PSI). At high tide, when birds were more abundant, bird communities were less similar among years at the Restoration Sites than at the Reference Sites. As habitat evolved at the Restoration Sites, bird communities changed over time, in contrast to the relatively stable Reference Sites. Over time, bird communities at the Restoration Sites became more similar to the communities at the Reference Sites. After five years, PSI values between the Restoration Sites and the Reference Sites were greater than average PSI values among years at the Reference Sites (a measure of natural variability). These comparisons provide evidence that the Restoration Sites now support bird communities that are roughly similar to the Reference Sites. These comparisons, however, cannot state whether these communities derive equal function between Restoration and Reference sites.

See Appendix B for the complete bird monitoring report.

5.0 Maintenance

A summary of all EBRPD maintenance activities performed at the site over the past five years is shown below.

Activity	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
fence repair			X	X	X
intertidal pond levee repair				X	
graffiti removal from fence posts	X				
invasive vegetation removal		X	X	X	X
irrigation system repair/maintenance	X	X	X	X	X
litter removal	X	X	X	X	X
Mosquito abatement consultation	X	X	X	X	X
mowing in marsh/landscape areas	X		X	X	X
native seed collection/propagation			X	X	
plant/shrub replacement		X	X	X	X
shrub pruning	X			X	X
soil replacement			X		
Spartina alterniflora identification	X	X	X	X	X
sprayed herbicide to kill weeds			X	X	X
spread mulch around shrubs in landscaped areas			X	X	X

6.0 Project Performance

The project performance evaluation has been organized according to the three groups of objectives for this restoration project: ecological, engineering, and maintenance. The following sections present the performance criteria that the project was required to meet within a five-year period and the stressor indicators that were intended to identify problems early on that may hinder the ability of the project to meets its performance criteria.

6.1 Ecological Objective 1: Provide Suitable Breeding Habitat for California Clapper Rail

The MMP (LFR 1999a) included one performance criterion and one stressor indicator for this objective.

6.1.1 Performance Criterion

Performance criterion 1-1. Positive trend in vegetation measurements, with CCR habitat defined as salt marsh plain dominated by a dense tall cover of pickleweed (*Salicornia virginica*) and/or cordgrass (*Spartina foliosa*) (LFR 1999a, pp.3-4).

Project performance on criterion 1-1. At the end of the fifth year following project construction, colonization by tidal marsh vegetation is progressing. Vegetative cover continued to increase in 2003, relative to 2002, 2001 and 2000 (Table 6). There are two primary constraints on meeting this performance criterion: establishment of the invasive smooth cordgrass, *Spartina alterniflora* (and its hybrids with the native species) and dominance of the annual (*Salicornia europaea*) versus perennial (*Salicornia virginica*) pickleweed. Necessary control efforts for *Spartina alterniflora* and its hybrids may preclude the Project from meeting this performance criterion and, until regional control measures are established, little if any further progress can be expected. Further, in Year 6 (2004), hybrids of the invasive cordgrass expanded in extent considerably, leading to this criterion not being met on the premise that the hybrids do not constitute Clapper Rail breeding habitat. Evaluating the significance of the annual versus perennial pickleweed is beyond this scope and is likely not great (Phyllis Faber, pers. comm.. 2003). Technically, the MMP calls for the perennial pickleweed, which is colonizing the site but slowly compared to annual pickleweed.

6.1.2 Stressor Indicator

Stressor indicator 1-1. Alkali bulrush (*Scirpus maritimus*) should not be present in large continuous patches (LFR 1999a, p.4).

Field evidence of stressor indicator 1-1. There is one small patch of alkali bulrush located at the southern central portion of the tidal portion of the site, between the intertidal pond and the seasonal wetlands. Percent cover increased from 5% in 2000 to 25% in 2002 within this small area (less then 6m of transect length), with no increase observed since then. No *Scirpus maritimus* has been observed elsewhere in the tidal portion of the site.

6.2 Ecological Objective 2: Support Waterfowl and Shorebirds

The MMP (LFR 1999a) included two performance criteria and no stressor indicators for this objective.

Performance criterion 2-1: Comparable numbers and species of shorebirds between the existing "loafing peninsula" near the Site, and the resting areas on the Site.

Project performance on criterion 2-1. During monitoring periods 2, 3, 4, and 5, comparable numbers and species of shorebirds were found on the "loafing peninsula" in the Eastern Reference site and the restoration sites. Therefore, performance criterion 2-1 has been met.

Performance criterion 2-2: Comparable numbers and species of shorebirds and waterfowl between the Site and nearby waterfowl and shorebird habitats.

Project performance on criterion 2-2. In all five monitoring periods, shorebird species richness and abundance in the restored tidal marsh has consistently equaled or exceeded that of either reference site. In the most recent monitoring period, waterfowl species richness and abundance in the tidal marsh was somewhat lower than that of the reference sites. This difference is due to the fact that several species restricted to deeper open-water habitat or higher tidal marsh habitat were found only in the reference sites. In the seasonal ponds, shorebird and waterfowl species richness and abundance equaled or exceeded that of both reference sites.

6.3 Ecological Objective 3: Support Intertidal Plant Communities

The MMP (LFR 1999a) included three performance criteria and one stressor indicator for this objective.

6.3.1 Performance Criteria

Performance criterion 3-1: The high marsh plain should develop a 50 percent cover of salt-marsh plant (generally dominated by pickleweed, saltgrass, jaumea, or alkali heath) within five years of Project construction (LFR 1999a, p.9).

Project performance on criterion 3-1. At the end of the fifth year following project construction, colonization by desired tidal marsh vegetation is progressing appropriately. The 2003 vegetation map (Figure 19) indicates total high marsh cover at 58% overall; Table 6 shows species composition along the vegetation transects, indicating appropriate species. Together, these data indicate that the Project has met this performance criterion.

Performance criterion 3-2: The low marsh plain should demonstrate a positive trend increasing toward a 50 percent cover of salt marsh plants dominated by cordgrass (*Spartina* spp.) (LFR 1999a, p.9).

Project performance on criterion 3-2. At the end of the fifth year following project construction, colonization by desired tidal marsh vegetation is progressing appropriately. The primary constraint on meeting this progress is establishment of the invasive smooth cordgrass, *Spartina alterniflora.* The 2003 vegetation map (Figure 19) indicates total low marsh cover at 47% overall, up from 43% in 2002 (Figure 18) and 39% in 2001 (Figure 17). The upward trend and the closeness to 50% cover in 2003 indicate vegetation colonization is effective. The annual pickleweed (*Salicornia europaea*) rather than *Spartina* comprised the dominant species (see Table 6). This criterion can be considered met relative to percent cover and open regarding species composition; year 6 site visit shows extensive *S. alterniflora* on the low marsh plain, raising the question of whether this criterion is met or failed.

Performance criterion 3-3: Over a period of five years, sedimentation should raise the average elevation of the low marsh plain from 5.5 to 5.75 ft Port Datum (LFR 1999a, p.9).

Project performance on criterion 3-3. Sedimentation appears to be occurring within the range of predicted values, suggesting positive progress toward meeting this performance criterion. Progress on low marsh accretion is best evaluated from the channel topographic cross sections (Figures 8, 9, and 10 and Table 3). In nearly all instances, it appears that low marsh has already accreted to 5.75 ft Port Datum or above.

6.3.2 Stressor Indicator

Stressor indicator 3-1: Within the tidal marsh areas, there should be no large (greater than 10 square meters), continuous patches of exotic, invasive species, or bare patches of ground present (LFR 1999a, p.9).

Field evidence of stressor indicator 3-1. Aside from smooth cordgrass (*Spartina alterniflora)*, no large patches of exotic, invasive species have become established. Percent bare ground is rapidly diminishing (see Figure 20 and compare the 2001, 2002, and 2003 vegetation maps in Figures 17, 18, and 19, respectively). Year 6 site visit shows extensive *S. alterniflora* colonization and expansion, making clear that without control this species could dominate the site.

6.4 Ecological Objective 4: Support Seasonal Ponds and Seasonal Vegetated Wetlands

The MMP (LFR 1999a) included seven performance criteria and one stressor indicator for this objective.

6.4.1 Performance Criteria

Performance criterion 4-1: Seasonal ponds 1 and 2 (see Figure 3) should develop a vegetation cover during the wet season (December through April) of less than 20 percent cover and consisting of annual species (LFR 1999a, p.12).

Project performance on criterion 4-1. Both seasonal ponds met this criterion (Table 7). In addition, Pond 3 also met this criterion though it is not required to do so under the MMP (LFR 1999a).

Performance criterion 4-2: The seasonal ponds should maintain 3 to 18 inches (10 to 59 cm) of water lasting 10 days after each of four storm events during the months of December through April in average rainfall years (LFR 1999a, pp.12-13).

Project performance on criterion 4-2. All three seasonal ponds are meeting this performance criterion. See Table 4.

Performance criterion 4-3: The total seasonal pond acreage should average 4.5 acres during the months of December through April (LFR 1999a, p.13).

Project performance on criterion 4-3. The ponds are meeting this criterion as over 4.5 acres of water remains in the ponds at least into, and sometimes well beyond, the April requirement. See Table 4.

Performance criterion 4-4: The seasonal ponds should have no significant erosion or sedimentation (LFR 1999a, p.13).

Project performance on criterion 4-4. None detected.

Performance criterion 4-5: The drainage basin divides should remain intact and not wash out during extreme storm events (LFR 1999a, p.13).

Project performance on criterion 4-5. Drainage basin divides remain intact.

Performance criterion 4-6: The seasonal vegetated wetlands surrounding the ponds should demonstrate, over the first five years, a positive trend increasing toward the long-term goal of at least 80 percent cover for two-thirds of the seasonal wetlands and 20 to 80 percent cover for the remaining one-third of the seasonal wetlands (LFR 1999a, p.13).

Project performance on criterion 4-6. Vegetations surveys for 2003 indicate a general increase in vegetative cover relative to 2002 (Tables 7 and 8). Monitoring methods prescribed in the MMP plus budget limitations did not provide extensive quantitative data to confirm this criterion, but the vegetation transects (Table 7) indicate the criterion will be met. EBRPD does implement mowing and other management in these areas during the dry months.

Performance criterion 4-7: Seasonal wetland vegetation surrounding ponds 1 and 2 should total at least 4.7 acres during average rainfall years (LFR 1999a, p.13).

Project performance on criterion 4-7. Insufficient monitoring resources are available to gather data for assessment of vegetation acreage. Percent cover of vegetation and bare ground were surveyed along transects from the centers of each pond (2 transects/pond) (Table 7). These surveys indicate that, as of 2003, there is an average of 78% vegetative cover between the six transects in the seasonal wetlands (Table 8).

6.4.2 Stressor Indicator

Stressor indicator 4-1: There should be no large (greater than 10 square meters), continuous patches of exotic, invasive species, or bare patches of ground (defined as having less than 10 percent cover of vegetation) present.

Field evidence of stressor indicator 4-1. This stressor indicator is difficult to evaluate because seasonally wet areas in California are commonly occupied and often dominated by introduced species. Such is the case for the seasonal wetlands (see Appendix A). Whether or not the species present are a problem is more difficult to determine. Species that are clearly problematic and were found in the seasonal wetland area (Pond 2 area) include French broom, sweet fennel, pampas grass, and yellow star thistle. None of these species were present in dense patches and they were largely restricted to the southern end of the site near the fence line.

6.5 Ecological Objective 5: Provide Upland Buffer and Upland Drainage Divide Habitat

The MMP (LFR 1999a) included two performance criteria and no stressor indicators for this objective.

Performance criterion 5-1: Vegetation cover of the upland buffer and drainage divide areas should have values of at least 40 percent, measured at the end of the growing season (LFR 1999a, p.16).

Project performance on criterion 5-1. Vegetation colonization is progressing toward meeting this criterion. Total vegetation cover in 2003 was higher than 2002 and is in the range to meet this criterion (Tables 7 and 8).

Performance criterion 5-2: The shrub plantings should have a survival rate of at least 70 percent during the first five years (LFR 1999a, p.16).

Project performance on criterion 5-2. Shrub survival has not been quantified in any of the monitoring reports, but EBRPD inspects shrub health and replaces dead plants during routine maintenance of the site (Section 4.0). Shrub survival rates may be determined in the future if EBRPD documents shrub populations at the beginning and end of the monitoring period, and keeps record of how many shrubs are replaced due to death.

6.6 Engineering Objective 1: Maintain Required Hydraulic and Tidal Circulation within the Restored Tidal Marsh

The MMP (LFR 1999a) included one performance criterion and no stressor indicators for this objective.

Performance criterion 6-1: Monitor and evaluate the hydraulic circulation within the marsh (LFR 1999a, p.17).

Project performance on criterion 6-1. Tidal inundation monitoring since 2000 indicates unrestricted tidal exchange (see Figures 12, 13, and 14).

6.7 Maintenance Objective 1: Prevent Excessive Levee Erosion

The MMP (LFR 1999a) included one performance criterion and no stressor indicators for this objective.

Performance criterion 7-1: Erosion of the perimeter levee shall result in a levee slope no greater than 1.5:1 (LFR 1999a, p.19)

Project performance on criterion 7-1. No significant levee erosion was observed at the site, based on walking the site perimeter and viewing aerial photographs.

6.8 Maintenance Objective 2: Maintain Plantings and Habitat Features

The MMP (LFR 1999a) included one performance criterion and four stressor indicators for this objective.

6.8.1 Performance Criterion

Performance criterion 8-1: Monitor, adjust water supply, and repair or replace damaged drip irrigation system components (LFR 1999a, p.20).

Project performance on criterion 8-1. EBRPD performed irrigation system repairs throughout the last 5 years (Section 5).

6.8.2 Stressor Indicators

Stressor indicator 8-1: Replace dead or dying shrubs promptly (LFR 1999a, p.20).

Field evidence of stressor indicator 8-1. EBRPD replaced dead or dying shrubs several times throughout the last 5 years (Section 5).

Stressor indicator 8-2: Replace cordgrass if survival rates drop below 70 percent (LFR 1999a, p.20).

Field evidence of stressor indicator 8-2. Due to colonization by the invasive *S. alterniflora* and legal restrictions on control measures during the monitoring period, native cordgrass transplants were not tracked nor replaced. The Invasive Spartina Project received its final program approval in September 2004, allowing control efforts to be implemented as budget is available.

Stressor indicator 8-3: Prune shrubs as needed (LFR 1999a, p.21).

Field evidence of stressor indicator 8-3. EBRPD pruned shrubs throughout the last 5 years.

Stressor indicator 8-4: The Site will be kept free of invasive vegetation with the following species targeted for removal: peppergrass (*Lepidium latifolium*), pampas grass (*Cortaderia selloana*), french broom (*Genista monspessulana*), star thistle (*Centaurea solstitialis*), and smooth cordgrass (*Spartina alterniflora*) (LFR 1999a, p.21).

Field evidence of stressor indicator 8-4: Removal of the above invasive plant species was done by EBRPD staff, with the assistance of volunteers. Relatively little removal appears to have been needed during the final monitoring period, and yellow star thistle was a main focus of weed removal activities (Section 5).

6.9 Maintenance Objective 3: Routine Park Operation

EBRPD staff maintained park amenities as needed. During the monitoring period, EBRPD removed litter from the marsh, removed invasive vegetation, planted native vegetation, mowed, watered and mulched around shrubs, replaced dead shrubs, maintained the irrigation system for the shrubs, and repaired damaged fence.

6.10 Maintenance Objective 4: Control Mosquito Breeding

EBRPD provides full access to the Alameda County Mosquito Abatement District for mosquito monitoring and control.

6.11 Maintenance Objective 5: Control Predators on California Clapper Rail

EBRPD has had no occurrences of red fox and thus has not had to implement any predator control efforts for that species. Park staff carry out ongoing control of cats and dogs at the site as part of routine park operations.

7.0 Compliance with Consent Decree Requirements

The Consent Decrees that directed completion of the Martin Luther King Jr. Regional Shoreline Wetlands Project required a final performance assessment based upon the design criteria in Exhibit E to the decrees, as modified through the Monitoring and Maintenance Plan for the project (LFR 1999a) approved by all the parties to the Consent Decrees. This report provides that final assessment.

Based upon the five years of monitoring completed from 1998 through 2003 and summarized in this report, EBRPD has made the following determinations regarding whether criteria were met or exceeded (Section 7.1), on track to be met or exceeded (Section 7.2), not met (Section 7.3), or monitoring could not provide a determination (Section 7.4).

7.1 Requirements Met or Exceeded

The project has met or exceeded the following performance criteria:

- **Ecological Objective 2, Criterion 2-1:** Comparable numbers and species of shorebirds between the existing “loafing peninsula” near the Site, and the resting areas on the Site.
- **Ecological Objective 2, Criterion 2-2:** Comparable numbers and species of shorebirds and waterfowl between the Site and nearby waterfowl and shorebird habitats.
- **Ecological Objective 3, Criterion 3-1:** The high marsh plain should develop a 50 percent cover of salt-marsh plant species (generally dominated by pickleweed, saltgrass, jaumea, or alkali heath) within five years of project construction.
- **Ecological Objective 3, Criterion 3-3:** Over a period of five years, sedimentation should raise the average elevation of the low marsh plain from 5.5 to 5.75 ft. Port Datum.
- **Ecological Objective 4, Criterion 4-1:** Seasonal ponds 1 and 2 should develop a vegetation cover during the wet season (December through April) of less than 20 percent cover and consisting of annual species.
- **Ecological Objective 4, Criterion 4-2:** The seasonal ponds should maintain 3 to 18 inches of water lasting 10 days after each of four storm events during the months of December through April in average rainfall years.
- **Ecological Objective 4, Criterion 4-3:** The total seasonal pond acreage should average 4.5 acres during the months of December through April.
- **Ecological Objective 4, Criterion 4-4:** The seasonal ponds should have no significant erosion or sedimentation.
- **Ecological Objective 4, Criterion 4-5:** The drainage basin divides should remain intact and not wash out during extreme storm events.
- **Engineering Objective 1:** Maintain required hydraulic and tidal circulation within the restored tidal marsh.
- **Maintenance Objective 1:** Prevent excessive levee erosion.
- **Maintenance Objective 2:** Maintain plantings and habitat features.

- **Maintenance Objective 3:** Routine park operation.
- **Maintenance Objective 4:** Control mosquito breeding.
- **Maintenance Objective 5:** Control predators on California clapper rail.

7.2 Requirements on Track to Be Met in the Near Future

The project is on track to meet the following performance criteria some time in the future:

- **Ecological Objective 4, Criterion 4-6:** The seasonal vegetated wetlands surrounding the ponds should demonstrate, over the first five years, a positive trend increasing toward the long-term goal of at least 80 percent cover for two-thirds of the seasonal wetlands and 20 to 80 percent cover for the remaining one-third of the seasonal wetlands.
- **Ecological Objective 5, Criterion 5-1:** Vegetation cover of the upland buffer and drainage divide areas should have values of at least 40 percent, measured at the end of the growing season.

7.3 Requirements Not Met

The project has not met the following performance criteria:

- **Ecological Objective 1, Criterion 1-1:** Positive trend in vegetation measurements, with California clapper rail habitat defined as salt marsh plain dominated by a dense tall cover of pickleweed (*Salicornia virginica*) and/or cordgrass (*Spartina foliosa*).

  Discussion. Necessary control efforts for *Spartina alterniflora* and its hybrids, and its significant expansion in Year 6 (2004), may preclude the project from meeting this performance criterion and, until regional control measures are established, little if any further progress can be expected. Once those regional control measures are established, the EBRPD will implement the measures for the project site subject to budget constraints.

- **Ecological Objective 3, Criterion 3-2:** The low marsh plain should demonstrate a positive trend increasing toward a 50 percent cover of salt marsh plants dominated by cordgrass (*Spartina* spp.)

  Discussion. While percent cover has been met, species composition has not been dominated by the native cordgrass. Instead, through year 5 the dominant vegetation was annual pickleweed, which typically colonizes lower-elevation tidal marsh areas and is replaced over time by slower colonizers as the site accretes. In year 6 the invasive cordgrass constitutued extensive cover. With control efforts now possible, meeting this criterion in the future may be possible.

7.4 Requirements for Which Monitoring Could Not Provide a Determination

The project monitoring could not provide determination about the following performance criteria:

- **Ecological Objective 4, Criterion 4-7:** Seasonal wetland vegetation surrounding ponds 1 and 2 should total at least 4.7 acres during average rainfall years.

  Discussion. The monitoring program did not include assessment of vegetation acreage. Instead, percent cover of vegetation and bare ground were surveyed along transects from the centers of each pond (2 transects/pond) and indicate vegetative growth occurs around the ponds.

- **Ecological Objective 5, Criterion 5-2:** The shrub plantings should have a survival rate of at least 70 percent during the first five years.

  Discussion. EBRPD inspects shrub health and replaces dead plants during routine maintenance of the site. EBRPD does not maintain quantitative records on shrub population status and replacement.

8.0 Major Lessons Learned

This section summarizes the major lessons learned from five years of monitoring at the Martin Luther King Jr. Regional Shoreline Wetland Restoration Project. Prior sections presented other, less major lessons learned. These lessons fall into three categories: restoration design, monitoring, and possible upcoming adaptive management and maintenance activities.

8.1 Restoration Design

The first and foremost lesson learned regarding restoration design is that the design succeeded in creating the target systems as measured by the performance criteria.

Tidal Marsh. For the tidal marsh component of the project, the questions faced during restoration design included target land surface elevations, substrate, and channel network configuration.

- **Land surface elevations.** The design opted to construct "low" and "high" marsh, which differed in elevation by approximately 0.5 ft. Both of these areas have performed to expectation and are likely to continue meeting performance criteria, albeit with the caveat for the invasive smooth cordgrass. Vegetation colonization stratified far more on distance from tidal source than it did on this elevation difference. Elevation does, however, tie into the substrate question.

- **Substrate.** The MLK site was filled tidal wetlands and mudflats. The post-construction marsh surface consisted of very compacted, gravelly soils, which are quite different from the low bulk density, fine grained soils typically found in natural tidal marshes. The project envisioned natural sedimentation over time depositing a layer of low bulk density, fine grained soils atop this substrate and thereby providing a more naturalistic substrate for plant and benthic organism colonization. Sedimentation has occurred, though the rates are relatively slow (as expected) due to low suspended sediment concentrations in tidal waters at this location. The substrate, land surface elevations, and patterns of vegetation colonization together suggest that constructing the marsh entirely at the "low" marsh elevation would have been more beneficial to the long-term outcome by leading to a thicker surface layer of naturally deposited marsh soils. However, the "high" marsh has not to date caused any detectable impediment and thus a better conclusion will likely be evident several more years from now.

- **Channel network configuration and geometry.** The data show that the channel network as designed and constructed has provided full, unimpeded tidal circulation across the site. Of particular interest during project design was the size of the channel at its connection to San Leandro Bay. At the time of design, two empirical models were considered, both using hydraulic geometry relationships that relate channel size to tidal prism (volume of water at high tide). These models (Collins, 1991 and PWA, 1995) yield large differences in channel top width and moderate differences in channel depth. Design engineers primarily based their final design on the Collins model, modified with 2:1 side slopes to improve geotechnical stability and ease of construction.

Intertidal Pond. For the intertidal pond component of the project, the questions faced during restoration design included pond bottom elevation and pond berm size that together define the hydroperiod of the pond. Apparently not addressed in design were the side slopes of the pond and the extent of shallow water habitat at different tide stages; the pond was built with relatively steep sides (roughly 3:1 to 5:1). The pond has succeeded in retaining shallow water at low tide continuously, providing important habitats for birds and their prey items. The only problem with the pond was a break in the berm about six feet wide that allowed greater low-tide drainage than intended; EBRPD repaired this break. The lesson from the berm failure is to examine the details of design and construction to determine whether greater strength could have been achieved to prevent a break, such as through greater compaction, a wider berm, gentler berm slopes, or other forms of reinforcement.

Seasonal Wetlands and Ponds. For the seasonal wetlands and ponds component of the project, the questions faced during restoration design included substrate permeability, drainage area, and avoidance of vegetation encroachment into the ponds. The design compacted the underlying soils and added and compacted bay mud soils excavated from the tidal marsh component of the project in order to maximize impermeability. These ponds have performed well beyond expectation in that they were consistently larger in size (peak total acreage each year ranged from 9.5 to 14.9 acres vs. criterion of 4.5 acres) and longer in duration (holding water into June or July each year vs. criterion of April) than required and should be considered a very positive example of how to provide non-tidal seasonal wetlands and ponds. Rainfall at the reference station (U.S. Forest Service Oakland South Station) during the monitoring period varied from 18.5 to 27.1 inches; the long-term (1888–2003) average annual rainfall at a nearby station in Berkeley is 24.19 inches. This comparison suggests that the results observed would be reflective of the longer-term conditions.

The only concern with the ponds has been a small amount of alkali bulrush (*Scirpus maritimus*) colonization, which results from the extended hydroperiod and the lack of ability to drain the ponds proactively (except with portable pumps). The bulrush, however, has been grazed by waterfowl, most likely Canada goose, which is keeping it under control.

Burrowing Owl Mounds. The constructed mounds and burrows were sporadically used by burrowing owls. This may be less indicative of poor design than it is of the owls' historical reluctance to use man-made burrows, even if the owls are "imprinted" on burrows (DiDonato, 2004, pers. comm.). This tendency was not helped by the destruction of some of the burrows by ground squirrels.

8.2 Monitoring

The monitoring approach itself has provided a number of lessons learned. The purpose of monitoring in projects like MLK is to gather the data necessary to determine whether the restoration is meeting prescribed performance criteria. Questions that arise when establishing a monitoring program include budget, indicators selected for monitoring, methods of gathering data for those indicators, and frequency and duration of monitoring. We have mentioned several lessons learned on the physical monitoring throughout Section 3.0; here we summarize these and other lessons.

- **Monitoring frequency and duration.** This monitoring program conducted annual monitoring of all parameters over the five-year period following reintroduction of tidal action and concluded after these five years. However, a single site visit in 2004, or year 6, indicated a significant change in vegetation conditions -- the major expansion in percent cover of the invasive cordgrass, *S. alterniflora* and its hybrids with the native cordgrass. At the conclusion of the five-year monitoring period, *S. alterniflora* and its hybrids were on the order of 5% cover, whereas in year 6 a casual observation shows cover to be at least 25%. Project performance criteria relating to establishing habitats for the endangered California clapper rail hinge on the native cordgrass establishing effectively, which it has not. Had the monitoring program reduced the monitoring frequency and increased the duration while maintaining overall level of effort, these post-monitoring conditions would be more effectively documented, with more up to date information available for informing corrective measures.

- **Aerial photography** is a very useful tool used in this monitoring effort. To conserve monitoring funds, photos were shared between different programs, in this case the Invasive Spartina Project. The main issues that arose were differences in photograph scale between years complicating interannual quantitative comparisons, highly variable accuracy of image rectification that could have been resolved with placement of permanent ground control points around the site perimeter, and differing times of year stemming from sharing photos between monitoring programs. But given all the limitations, the results have proven to be very effective in tracking site evolution.

- **Horizontal and vertical control for topographic data** presented some problems. The horizontal control issue arose in large part from the very large amount of marker poles installed at the site by many entities for a variety of purposes and few if any of these poles being labeled. The vertical control issue arose from disturbance of secondary benchmarks and early data not being clear on how it addressed vertical control. Both issues are readily fixed by setting out well-marked control at monitoring outset.

- **Sediment accretion** was the single greatest challenge to measure and the methods applied all came up short. The site experiences relatively low sedimentation rates, which requires a sensitive method to quantify the rates accurately. The monitoring plan called for sediment pins, a simple and low-cost method that is not well suited to such conditions. We tried to apply channel cross section topographic data, which provided some insight but was not intended for this purpose. The site also experienced relatively high public use for monitoring, maintenance, and education. This use had two effects: first, it may have inadvertently trampled monitoring locations thereby altering results; and second, it placed numerous marker poles across the marsh plain, none of which were labeled, leading to confusion with unlabeled monitoring markers. The former problem could have been resolved by creating exclusion areas and the latter problem could have been resolved with permanent labeling of marker poles. Finally, alternative methods may have been appropriate; the low-cost rough approach is to measure thickness of deposited sediment with a measuring stick which would work reasonably well with the hard underlying substrate. The high-cost precise approach is Sediment Elevation Tables, which can yield very high-resolution, accurate data but are very complex to install and utilize.

- **Water quality** monitoring needs to have better defined purposes and a methodology consistent with meeting that purpose. The single annual data point for five locations provides limited utility. At MLK, water quality sampling may have been most useful as a diagnostic tool for other problems such as widespread soil discoloration, poor vegetation establishment, etc. Alternatively, a more comprehensive water quality monitoring effort could have been implemented if a budget were available, to address temporal patterns on several time scales from tidal cycle to spring-neap tides to seasonal.

8.3 Adaptive Management and Maintenance

Adaptive management is a tool that provides feedback to site management activities based on monitoring data and the lessons those data provide. For example, if monitoring results indicated site progress on vegetation colonization was not going to meet performance criteria, a series of actions would ensue, first to determine the nature of the problem then to identify possible solutions and finally to inform future restoration design efforts. In the maintenance context, adaptive management provides monitoring data to identify what maintenance items are necessary and it provides a means to determine whether an alternate approach could be used to minimize maintenance effort.

At the MLK site during the five-year monitoring period, there have been no adverse outcomes requiring application of adaptive management tools to resolve. What has been necessary are a number of maintenance items, all anticipated. Weed removal has been required, shrub replacement has been necessary, and some facilities have required repair (fences, irrigation systems, etc.). These scheduled maintenance activities at the outset were not scheduled into a rigorous adaptive management context, so data collection, detailed record keeping, and data analysis were generally not performed at the level needed to support adaptive management. The one area in which such effort may have been helpful is weed management in the seasonal wetland areas; it is generally assumed that such systems require ongoing maintenance yet a number of possible strategies may exist and with an adaptive management approach, testing of some of those strategies could have been implemented (if budget were available).

The one component for which adaptive management can now come into play is addressing the year 6 significant increase in invasive *Spartina* percent cover. At the same time, the Invasive Spartina Project received its final program approvals in fall 2004, allowing control measures to be implemented. Somehow, the efficacy of those measures needs to be monitored if the Project is to meet its Clapper Rail habitat targets.

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Tables

Table 1
Schedule of Monitoring Activities, 1999 - 2003
Martin Luther King, Jr. Shoreline Regional Park Wetland Restoration

Monitoring Activities Completed in Fall 2002 to Fall 2003 Monitoring Period

	Description	2002			2003										
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1. Ecology															
A	Vegetation survey								14					5	
B	Plant community acreage													5	
C	Weed invasion								14					5	
D	Loafing island vegetation													5	
E	Birds (Audubon)[1]	four surveys per month during this period													
2. Hydrology and geomorphology															
A	Channel cross sections									4					
B	Sediment pins			data not collected this monitoring year											
C	Seasonal pond size			19	22		12		2	4					
D	Tidal circulation									6	29				
E	Velocity, turbidity and water quality			data not collected this monitoring year											
F	Channel meander											29			
G	Air photo											29			

Monitoring Activities Completed in Fall 2001 to Fall 2002 Monitoring Period

	Description	2001			2002										
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1. Ecology															
A	Vegetation survey							24							5
B	Plant community acreage											26			
C	Spartina transplants		not applicable this year												
D	Weed invasion							24							5
E	Loafing island vegetation														5
F	Birds (Audubon)[1]														
2. Hydrology and geomorphology															
A	Channel cross sections											1			
B	Sediment pins		not applicable this year												
C	Seasonal pond size			7		1	1	24							
D	Tidal circulation		not applicable this year												
E	Velocity, turbidity and water quality		not applicable this year												
F	Channel meander											26			
G	Air photo											26			

Table 1, continued
Schedule of Monitoring Activities, 1999 - 2003
Martin Luther King, Jr. Shoreline Regional Park Wetland Restoration

Monitoring Activities Completed in Fall 2000 to Fall 2001 Monitoring Period

	Description	2000			2001								
		Oct	Nov[3]	Dec	Jan[3]	Feb[3]	Mar	Apr	May	Jun	Jul	Aug	Sep
1. Ecology													
A	Vegetation survey		2				22	26					6
B	Plant community acreage												6
C	Spartina transplants												6
D	Weed invasion		2					26					6
E	Loafing island vegetation												6
F	Birds (Audubon)[2]	X	X	X	X	X	X	X					
2. Hydrology and geomorphology													
A	Channel cross sections				3						12	24	
B	Sediment pins											24	
C	Seasonal pond size				3	1	22	26			12		
D	Tidal circulation				3	1					12	24	
E	Velocity, turbidity and water quality											24	
F	Channel meander												
G	Air photo										24		

Monitoring Activities Completed in Fall 1999 to Fall 2000 Monitoring Period

	Description	1999			2000								
		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1. Ecology													
A	Vegetation survey												X
B	Plant community acreage												X
C	Spartina transplants												X
D	Weed invasion												X
E	Loafing island vegetation												X
F	Birds (Audubon)[4]												
2. Hydrology and geomorphology													
A	Channel cross sections												X
B	Sediment pins												X
C	Seasonal pond size[5]					X					X		
D	Tidal circulation												
E	Velocity and turbidity												X
F	Channel meander												X
G	Air photo												X

Notes:
1 Grey-shaded boxes denote data collected at multiple intervals during period indicated.
2 Henkel report on Audubon data covers Aug 99-Apr 00 results. Aug 00-Apr 01 results expected to be included in the final 2001 monitoring report
3 These data previously reported in Fall 1999 to Fall 2000 report (WWR, 2001a).
4 Audubon will complete database entry in February 2001 for Oct 99 to Apr 00 data.
5 Seasonal pond area measurements preceded Siegel contract; data provided by EBRPD.

Table 2
Sediment Accretion from Sediment Pins 1998-2001
MLK Jr. Regional Shoreline Wetlands Project
Oakland, California

Location	Sample Date	Time Since Baseline (yr)	Distance from Top of Pin to Ground Surface[1] (m)	Sediment Deposition, m Calculated[2,3]		Deposition Rate, m/yr From Calculated Deposition ±0.007		Comments
				Interval	Cumulative	Interval	Cumulative	
A. Sediment Pins Located at Edge of Seasonal Ponds (see locations in Figure 2)								
SP-1	7-Jan-99		Data Problem[4]					East Edge of Pond 1
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.800					
	24-Aug-01	0.81	0.798	0.002	0.002	0.002	0.002	
SP-2	7-Jan-99		Data Problem[4]					North Edge of Pond 1
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.850					
	24-Aug-01	0.81	0.854	-0.004	-0.004	-0.005	-0.005	
SP-3		--	--	--	--	--	--	** Pin Missing **
SP-4	7-Jan-99		Data Problem[4]					North Edge of Pond 2
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.900					
	24-Aug-01	0.81	0.928	-0.028	-0.028	-0.035	-0.035	
SP-5	7-Jan-99		Data Problem[4]					West Edge of Pond 3
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.800					
	24-Aug-01	0.81	0.780	0.020	0.020	0.025	0.025	
SP-6	7-Jan-99		Data Problem[4]					North Edge of Pond 3
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.690					
	24-Aug-01	0.81	0.686	0.004	0.004	0.005	0.005	
Statistics:								
1. **Mean**				**-0.001**	**-0.001**	**-0.001**	**-0.001**	
2. Median				0.002	0.002	0.002	0.002	
3. Maximum				0.020	0.020	0.025	0.025	
4. Minimum				-0.028	-0.028	-0.035	-0.035	

Table 2
Sediment Accretion from Sediment Pins 1998-2001
MLK Jr. Regional Shoreline Wetlands Project
Oakland, California

Location	Sample Date	Time Since Baseline (yr)	Distance from Top of Pin to Ground Surface[1] (m)	Sediment Deposition, m: Calculated[2,3] Interval	Sediment Deposition, m: Calculated[2,3] Cumulative	Deposition Rate, m/yr: From Calculated Deposition ±0.007 Interval	Deposition Rate, m/yr: From Calculated Deposition ±0.007 Cumulative	Comments
B. Sediment Pins Located within Tidal Marsh (see locations in Figure 2)								
Low Marsh								
SP-7	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					
	2-Nov-00		Data Problem[5]					
	24-Aug-01		Data Problem[5]					
SP-9	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					
	2-Nov-00		Data Problem[5]					
	24-Aug-01		Data Problem[5]					
Statistics:								
1. **Mean**				**n/a**	**n/a**	**n/a**	**n/a**	
2. Median				n/a	n/a	n/a	n/a	
3. Maximum				n/a	n/a	n/a	n/a	
4. Minimum				n/a	n/a	n/a	n/a	
High Marsh								
SP-8	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.440					
	12-Aug-01	0.78	0.435	0.005	0.005	0.006	0.006	
SP-10	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					

Table 2
Sediment Accretion from Sediment Pins 1998-2001
MLK Jr. Regional Shoreline Wetlands Project
Oakland, California

Location	Sample Date	Time Since Baseline (yr)	Distance from Top of Pin to Ground Surface[1] (m)	Sediment Deposition, m Calculated[2,3] Interval	Sediment Deposition, m Calculated[2,3] Cumulative	Deposition Rate, m/yr From Calculated Deposition ±0.007 Interval	Deposition Rate, m/yr From Calculated Deposition ±0.007 Cumulative	Comments
	2-Nov-00	0.00	bent					
	24-Aug-01	0.81	0.688					
SP-11	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.910					
	24-Aug-01	0.81	0.890	0.020	0.020	0.025	0.025	
SP-12	18-Jul-98		Data Problem[4]					
	7-Jan-99		Data Problem[4]					
	10-Oct-99		Data Problem[4]					
	2-Nov-00	0.00	0.640					
	24-Aug-01	0.81	0.609	0.031	0.031	0.038	0.038	
Statistics:								
1. **Mean**				**0.019**	**0.014**	**0.023**	**0.023**	
2. Median				0.020	0.020	0.025	0.025	
3. Maximum				0.031	0.031	0.038	0.038	
4. Minimum				0.005	0.005	0.006	0.006	

Notes:
1. Uncertainty in measurement of sediment pin to ground surface distance is approximately ±0.005 m (0.5 cm); therefore, any changes less than this value must be considered no change.
2. Calculated sediment deposition that denotes loss of sediment could be attributed to measurement error, not actual sediment loss.
3. Calculated sediment deposition is difference of sequential measurements of distance from top of sediment pins to ground surface.
4. Baseline and six-month data reported in the year-one monitoring report (LES 1999) did not match that reported in six-month monitoring report (LFR 1999b). Problems included unit conversion (meters-feet) errors and reported field measurements that computed unreasonable results. Original field notes are not available to determine what values should be reported, so all suspect data from 1998 and 1999 have been removed from this table.
5. Sediment pin measurements at SP-7 and SP-9 for 2000 and 2001 showed unreasonably large amounts of erosion (approximately 0.5 m difference), which leads us to believe that during one of those two sampling events, we took measurements from other markers instead of the sediment pins installed by LFR. The sediment pins had no distinctive identification markings and were located amongst many similar unmarked PVC pipes in the area set out by other monitoring groups.

Table 3
Tidal Marsh Sediment Accretion Estimates from Marsh Plain Topography, 2001-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Marsh Type[1]	Cross Section Location	Average Elevation[2] Port Datum (m) 2001	(m) 2002	(m) 2003	(ft) 2001	(ft) 2002	(ft) 2003	Elevation Difference (m) 2001-02	2002-03	2001-03	Interval Sediment Accretion Rate (m/yr)[3] 2001-02	2002-03	Cummulative Sediment Accretion Rate[4] (m/yr) 2001-03
Low:													
XS-1E	Left Bank	1.674	1.704	1.697	5.489	5.589	5.566	0.030	-0.007	0.023	0.029	-0.007	0.011
XS-1W	Right Bank	1.780	1.787	1.779	5.839	5.860	5.835	0.006	-0.008	-0.001	0.006	-0.008	-0.001
XS-2E	Left Bank	1.785	1.791	1.765	5.856	5.874	5.791	0.006	-0.026	-0.020	0.005	-0.026	-0.010
XS-2W	Left Bank	1.750	1.797	1.799	5.741	5.895	5.901	0.047	0.002	0.049	0.044	0.002	0.024
XS-2W	Right Bank	1.714	1.740	1.742	5.622	5.706	5.713	0.026	0.002	0.028	0.024	0.002	0.014
XS-3	Left Bank	1.717	1.739	1.721	5.632	5.703	5.645	0.022	-0.018	0.004	0.021	-0.018	0.002
Statistics:													
	Mean:	1.737	1.760	1.751	5.697	5.771	5.742	0.023	-0.009	0.014	0.022	-0.009	0.007
	Minimum:	1.674	1.704	1.697	5.489	5.589	5.566	0.006	-0.026	-0.020	0.005	-0.026	-0.010
	Maximum:	1.785	1.797	1.799	5.856	5.895	5.901	0.047	0.002	0.049	0.044	0.002	0.024
	Standard Deviation:	0.043	0.038	0.038	0.142	0.123	0.124	0.016	0.011	0.024	0.015	0.011	0.012
High:													
XS-1E	Right Bank	1.880	1.900	1.953	6.168	6.233	6.406	0.020	0.053	0.073	0.019	0.053	0.035
XS-1W	Left Bank	1.913	1.920	1.926	6.274	6.296	6.318	0.007	0.007	0.013	0.007	0.007	0.007
XS-2E	Right Bank	1.880	1.875	1.846	6.168	6.151	6.056	-0.005	-0.029	-0.034	-0.005	-0.029	-0.017
XS-3	Right Bank	1.859	1.862	1.856	6.096	6.106	6.088	0.003	-0.005	-0.003	0.003	-0.006	-0.001
Statistics:													
	Mean:	1.883	1.889	1.895	6.176	6.197	6.217	0.006	0.006	0.012	0.006	0.006	0.006
	Minimum:	1.859	1.862	1.846	6.096	6.106	6.056	-0.005	-0.029	-0.034	-0.005	-0.029	-0.017
	Maximum:	1.913	1.920	1.953	6.274	6.296	6.406	0.020	0.053	0.073	0.019	0.053	0.035
	Standard Deviation:	0.022	0.026	0.052	0.073	0.085	0.172	0.010	0.034	0.045	0.010	0.035	0.022

Notes:
1. Marsh type (low or high) used to separate data for calculating respective accretion estimates.
2.Tidal marsh sediment accretion estimates are based on 2001, 2002, and 2003 channel cross section survey data (Figures 3-5; Appendix B).
3. Interval accrection rate measures from one year to the next.
4. Cumulative accretion rate measures from first measurement to most recent measurement.

Table 4
Seasonal Ponds Depths and Acreages 1998-2003
MLK Jr. Regional Shoreline Wetlands Project
Oakland, California

Date	Pond 1		Pond 2		Pond 3		Total Ponded Area (acres)
	Depth (ft)	Area (acres)	Depth (ft)	Area (acres)	Depth (ft)	Area (acres)	
1998-1999 Monitoring Year[1]							
Water Year 1998-1999 Total Rainfall = 24.08 inches (see Table 5)							
28-Nov-98	0.92	2.63	1.80	2.87	0.46	0.78	6.3
19-Dec-98	1.05	2.71	2.03	3.15	0.59	0.97	6.8
20-Jan-99	1.57	3.00	2.43	3.58	0.66	1.20	7.8
23-Mar-99	3.28	7.11	Overtopped[2]	6.40	1.41	1.42	14.9
17-Apr-99	2.79	6.32	Overtopped[2]	5.61	0.66	1.18	13.1
7-May-99	2.17	5.62	3.15	4.90	0.66	1.06	11.6
24-Jun-99	0.72	2.40	0.85	0.82	n/a	Dry	3.2
16-Jul-99	n/a	Dry	n/a	Dry	n/a	Dry	0.0
1999-2000 Monitoring Year[1]							
Water Year 1999-2000 Total Rainfall = 27.12 inches (see Table 5)							
9-Feb-00	1.87	4.73	2.43	3.60	0.66	1.13	9.5
6-Jul-00	n/a	2.40	n/a	0.82	n/a	Dry	3.2
2000-2001 Monitoring Year[3]							
Water Year 2000-2001 Total Rainfall = 18.53 inches (see Table 5)							
3-Jan-01	0.60	0.56	0.91	0.35	n/a	Dry	0.9
1-Feb-01	1.22	2.87	1.75	1.01	0.75	0.37	4.3
22-Mar-01	2.21	5.28	2.76	4.01	1.72	0.64	9.9
26-Apr-01[4]	1.76	4.7	2.29	3.3	1.30	1.0	9.0
12-Jul-01	n/a	Dry	n/a	Dry	n/a	Dry	0.0
2001-2002 Monitoring Year							
Water Year 2001-2002 Total Rainfall = 24.32 inches (see Table 5)							
7-Dec-01[4]	1.90	5.0	2.40	3.6	1.42	1.1	9.7
1-Feb-02[4]	2.54	6.9	3.19	5.5	1.88	1.6	14.0
1-Mar-02[5]	2.40	6.61	3.20	5.53	1.7	1.38	13.5
24-Apr-02[4]	2.30	6.3	2.86	3.9	1.50	0.6	10.8
2002-2003 Monitoring Year							
Water Year 2002-2003 Total Rainfall = 25.89 inches (see Table 5)							
19-Dec-02	2.05	6.20	2.63	5.04	1.62	1.40	12.6
22-Jan-03[4]	2.55	7.0	3.25	5.5	1.89	1.6	14.1
12-Mar-03	2.34	6.20	2.99	4.82	1.75	1.31	12.3
2-May-03	2.17	5.42	2.70	3.02	1.58	1.15	9.6
4-Jun-03	1.53	5.50	1.91	3.90	0.83	1.20	10.6

Notes:
1. 1998-1999 and 1999-2000 data provided by previous monitoring efforts.
2. Pond 2 staff gauge is 3.49 ft tall in 1999.
3. All staff gauges replaced between fall and winter 2000.
4. Pond acreages estimated from stage-area curves (Figure 16).
5. Pond depths estimated from stage-area curves (Figure 16)

Table 5
Rainfall Totals, October 1998 to September 2003
MLK Jr. Regional Shoreline Wetlands Project
Data from U.S. Forest Service Oakland South Station, Oakland, California

Date	Daily Rainfall Totals (inches)												Water Year Total (in)
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
1998 - 1999	**0.00**	**3.57**	**1.59**	**5.07**	**8.26**	**3.54**	**1.71**	**0.00**	**0.00**	**0.00**	**0.13**	**0.21**	**24.08**
1999 - 2000	**0.20**	**4.10**	**0.63**	**7.73**	**10.24**	**1.89**	**0.99**	**1.34**	**0.00**	**0.00**	**0.00**	**0.00**	**27.12**
2000 - 2001	**1.67**	**0.78**	**1.34**	**3.54**	**7.01**	**1.55**	**2.25**	**0.00**	**0.18**	**0.00**	**0.00**	**0.21**	**18.53**
2001 - 2002	**0.47**	**4.52**	**10.07**	**1.85**	**2.35**	**4.14**	**0.32**	**0.58**	**0.02**	**0.00**	**0.00**	**0.00**	**24.32**
2002 - 2003	**0.00**	**3.29**	**12.80**	**1.12**	**1.73**	**1.51**	**4.35**	**1.06**	**0.00**	**0.00**	**0.00**	**0.03**	**25.89**

Notes :

1. Data source: http://cdec.water.ca.gov/queryCSV.html, OSO station, sensor 45. The data is provisional and unverified.
2. Rainfall for 12 Sep 2003 was reported as 23.91 inches by CDEC. We excluded this value from our rainfall calculations and labelled it as a missing data value, as empirical evidence suggests the excessively high rainfall value during the dry season was recorded in error.

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)					
Start	**End**	**Species**	**Percent cover**	**Height (m)**	**Comments**
Transects V1, V2 and V3, all start from "center stake" located in tidal marsh immediately north of intertidal pond. Transects V4 and V5 cross marsh to the north of other transects. All transect locations shown in Figure 2. All surveys by Vir McCoy.					
Transect V1, 5-Oct-2003					Bearing 250 deg from center stake in line with park bench
0	2	*Salicornia europaea*	80		
		Bare ground	20		
2	36	*Salicornia europaea*	15		
		Bare ground	85		
36	50.5	*Salicornia europaea*	95		
		Spartina spp.	1		One plant, likely *S. alterniflora.* Indeterminant hybrids possible
		Bare ground	5		
50.5	52.5	Small channel	100		
52.5	94.5	*Salicornia europaea*	85		
		Spartina spp.	1		Indeterminant hybrids possible
		Bare ground	15		
94.5	100	Small channel	100		
100	157	*Salicornia europaea*	80		
		Spartina spp.	1		Indeterminant hybrids possible
		Bare ground	20		
157	159	*Polypogon monspeliensis*	2		Edge species
		Spartina spp.	10		Indeterminant hybrids possible. Edge species
		Distichlis spicata	50		Edge species
		Triglochin concinna	5		Edge species
		Spartina spp.	10		Edge species. Didn't come through on photocopy
		Bare ground	25		
Bare Ground (excluding channel):			**32%**		
Transect V1, 5-Nov-2002					Bearing 250 deg from center stake in line with park bench
0	1.8	*Salicornia europaea*	70	0.2	Average height
		Bare ground	30		
1.8	36	Bare ground	70		Open area
		Salicornia europaea	30		
36	50.5	*Salicornia europaea*	75		
		Bare ground	25		
50.5	52.5	Small channel	100		
52.5	75.7	*Salicornia europaea*	90	0.2	
		Salicornia virginica	5		
		Spartina spp.	1		Indeterminant hybrids possible.
		Bare ground	5		
75.7	86	Bare ground	100		Open area
86	94.5	*Salicornia europaea*	95		
		Spartina spp.	1		Indeterminant hybrids possible.
		Bare ground	5		
94.5	99	Channel	100		
99	157	*Salicornia europaea*	75		
		Salicornia virginica	1		
		Bare ground	25		
157	159	*Salicornia europaea*	40		Edge species
		Distichlis spicata	25		Edge species
		Spartina spp.	20		Indeterminant hybrids possible. One clump at edge
		Salicornia virginica	5		One clump at edge
Bare Ground (excluding channel):			**36%**		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m) Start	End	Species	Percent cover	Height (m)	Comments
Transect V1, 6-Sep-2001					
0	40	Bare ground	95		
		Salicornia virginica	1		Edge
		Salicornia europaea	2		Spreading
40	78	*Salicornia europaea*	50		
		Bare ground	50		
78	88	Bare ground	100		
88	94	*Salicornia europaea*	50		
		Bare ground	50		
94	96	Channel	100		
96	159	*Salicornia europaea*	55		
		Bare ground	40		
Bare Ground (excluding channel):			**61%**		
Transect V1, 2-Nov-2000					
0	94	Bare ground/algae	95		Constructed low marsh to channel
		Salicornia virginica	1		
		Salicornia europaea	2		
94	96	Channel	100		
96	159	Bare ground/algae	95		Minimal algae, constructed high marsh to end
		Salicornia europaea	2		Few scattered
		Salicornia virginica	2		Mostly on edge
		Distichlis spicata	1		
Bare Ground (excluding channel):			**95%**		
Transect V2, 5-Oct-2003					
0	55.5	*Salicornia europaea*	63		
		Spartina spp.	2		Indeterminant hybrids possible
		Bare ground	40		
55.5	60	Channel	100		
60	99	*Salicornia europaea*	75		This section of transect runs along edge of veg/open area
		Spartina spp.	2		Indeterminant hybrids possible
		Bare ground	20		
		Salicornia virginica	3		
99	103	Channel	100		
103	179	*Spartina* spp.	5		Indeterminant hybrids possible
		Salicornia europaea	75		
		Bare ground	20		
Bare Ground (excluding channel):			**27%**		
Transect V2, 5-Nov-2002					Bearing 70 deg from center stake, in line with PVC in distance
0	31	*Salicornia europaea*	60	0.2	Average height
		Bare ground	40		
31	47.5	Bare ground	70		
		Salicornia europaea	30		
47.5	55.5	*Salicornia europaea*	100		
		Spartina spp.	1		Indeterminant hybrids possible
55.5	73.5	Bare ground	50		This section of transect runs along edge of veg/open area
		Salicornia europaea	45		
		Salicornia virginica	5		
73.5	99	*Salicornia europaea*	80		
		Spartina spp.	1		Indeterminant hybrids possible
		Salicornia virginica	5		
		Bare ground	10		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)		Species	Percent cover	Height (m)	Comments
Start	End				
99	103	Channel	100		
103	179	*Salicornia europaea*	70		
		Salicornia virginica	5		
		Spartina spp.	5		Indeterminant hybrids possible
		Spartina spp.	1		Indeterminant hybrids possible. Along bank
		Bare ground	20		
Bare Ground (excluding channel):			**29%**		
Transect V2, 6-Sep-2001					
0	46.8	Bare ground	100		
46.8	100	*Salicornia europaea*	60	0.25	
		Salicornia virginica	5	0.35	
		Bare ground	35		
100	102	Channel	100		
102	135	*Salicornia europaea*	70		
		Salicornia virginica	5		
		Bare ground	25		
		Spartina foliosa	1		Indeterminant hybrids possible
135	145.5	*Salicornia europaea*	5		
		Bare ground	95		
145.5	162	*Salicornia europaea*	90		
		Spartina foliosa	3	0.2	Indeterminant hybrids possible
		Bare ground	5		
162	177	Bare ground	100		
177	179	*Spartina alterniflora*	10	0.4	Indeterminant hybrids possible
		Salicornia virginica	65	0.2	
		Spartina foliosa	5		Indeterminant hybrids possible
		Bare ground	20		
Bare Ground (excluding channel):			**56%**		
Transect V2, 2-Nov-2000					
0	47.7	Bare ground/algae	100		Pockets of water, constructed low marsh to channel
47.7	100	*Salicornia europaea*	35	0.2	Mostly dead w/ new sprouts
		Salicornia virginica	4	0.3	
		Distichlis spicata	1		
		Bare ground	60		
100	102	Channel	100		
102	119.6	*Salicornia europaea*	20		Constructed high marsh to end
		Salicornia virginica	10		
		Bare ground	70		
119.6	145	*Salicornia europaea*	5		
		Bare ground	95		
145	176	*Salicornia europaea*	15		
		Spartina foliosa	3	0.2	Approx. 25 plants. Indeterminant hybrids possible
		Bare ground	80		
176	179	*Spartina alterniflora*	35	0.4	Dense strip along edge. Indeterminant hybrids possible
		Salicornia virginica	65	0.2	Edge of marsh
Bare Ground (excluding channel):			**79%**		
Transect V3, 5-Oct-2003					Bearing 150 deg from center stake, in line with flag in distance
0	2.5	*Salicornia europaea*	95	0.2	
2.5	35.5	Bare ground	100		
35.5	40.6	*Salicornia europaea*	5	0.2	
		Salicornia virginica	70		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)				Height	
Start	End	Species	Percent cover	(m)	Comments
		Bare ground	25		Channel bank
40.6	114.5	Bare ground/pond	100		Intertidal pond (not in bare ground calc)
114.5	120	*Salicornia virginica*	60		
		Frankenia salina	5		
		Distichlis spicata	5		
		Bare ground	30		
120	163	*Salicornia europaea*	15	0.2	
		Bare ground	85		
		Salicornia virginica	2		
163	169	*Scirpus maritimus*	25		Edge species
		Triglochin concinna	5		Edge species
		Spartina spp.	20		Indeterminant hybrids possible. Edge species
		Distichlis spicata	25		Edge species
		Typha latifolia	5		Edge species
		Salicornia virginica	5		Edge species
		Salicornia europaea	10	0.2	Edge species
Bare Ground (excluding channel):			**74%**		
Transect V3, 5-Nov-2002					Bearing 150 deg from center stake, in line with flag in distance
0	2.5	*Salicornia europaea*	75	0.2	
		Bare ground	25		
2.5	35.5	Bare ground	100		
35.5	40.6	*Salicornia virginica*	35		Bank
		Spartina spp.	1		Indeterminant hybrids possible. Bank
		Salicornia europaea	15		Bank
		Bare ground	50		Bank
40.6	114.6	Bare ground/ pond water	100		
114.6	163	Bare ground	85		Marsh
		Salicornia virginica	10		Marsh
		Salicornia europaea	2		Marsh
		Jaumea carnosa	1		Marsh
163	168.6	*Triglochin concinna*	15		Edge
		Scirpus maritimus	25		Edge
		Distichlis spicata	30		Edge
		Spartina spp.	20		Indeterminant hybrids possible. Edge
		Typha latifolia	10		Edge
Bare Ground (excluding channel):			**89%**		
Transect V3, 6-Sep-2001					
0	35.6	Bare ground	100		
35.6	40.6	*Salicornia europaea*	10		
		Salicornia virginica	10		
		Bare ground	80		
40.6	114.6	Bare ground/pond water	0		
114.6	163.6	Bare ground	95		
		Salicornia europaea	5		
163.6	168.6	*Triglochin concinna*	10		
		Scirpus maritimus	10		
		Distichlis spicata	20		
		Cotula coronopifolia	10		
		Spartina alterniflora	25		Indeterminant hybrids possible
		Typha latifolia	5		
		Bare ground	20		
Bare Ground (excluding channel):			**98%**		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)					
Start	**End**	**Species**	**Percent cover**	**Height (m)**	**Comments**
Transect V3, 2-Nov-2000					
0	35.6	Bare ground	100		Constructed low marsh to intertidal pond
35.6	40.6	*Salicornia europaea*	5		Berm forming northern edge of intertidal pond
		Salicornia virginica	5		
		Bare ground	80		
40.6	114.6	Bare ground/pond water	100		Intertidal pond
114.6	163.6	Bare ground/algae	98		Minimal algae, constructed high marsh to end
		Salicornia europaea	2		
163.6	168.6	*Triglochin coccina*	10		
		Scirpus maritimus	5	0.5	Small patch
		Distichlis spicata	15		
		Cotula coronopifolia	20		
		Spartina alterniflora	20		Indeterminant hybrids possible.
		Bare ground	30		
168.6	end				Seasonal wetlands -- see Table 10
Bare Ground (excluding channel):			**98%**		
Transect V4, 6-Oct-2003					Bearing 70 deg from gate at south end of main parking lot
0	3	*Avena fatua*	50		Weedy edge.
		Bromus spp.	50		Weedy edge.
3	33	*Salicornia europaea*	80	0.2	
		Salicornia virginica	10	0.3	
		Spartina spp.	5		Indeterminant hybrids possible.
		Bare ground	5		
33	41	Channel	100		
41	79	*Salicornia europaea*	80	0.2	
		Spartina spp.	5		Indeterminant hybrids possible
		Distichlis spicata	5		
		Bare ground	5		
		Salicornia virginica	5	0.3	
79	83	*Spartina* spp.	85		Indeterminant hybrids possible
		Salicornia virginica	10	0.3	
		Distichlis spicata	5		
		Grindelia stricta	2		
Bare Ground (excluding channel):			**5%**		
Transect V4, 5-Nov-2002					Bearing 70 deg from gate at south end of main parking lot
0	3	*Bromus hordeaceous*	35		Ruderal to edge of Wetland
		Avena fatua	20		
		Hirschfeldia incana	10		
		Bare ground	35		
3	33	*Salicornia europaea*	85		
		Salicornia virginica	5		
		Spartina spp.	2		Indeterminant hybrids possible
		Distichlis spicata	1		
		Bare ground	10		
33	41	Channel	100		
41	80	*Salicornia europaea*	50		
		Salicornia virginica	5		
		Spartina spp.	5		Indeterminant hybrids possible
		Bare ground	40		
80	82.7	*Salicornia virginica*	15		
		Salicornia europaea	5		
		Spartina spp.	80		Indeterminant hybrids possible
Bare Ground (excluding channel):			**26%**		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)		Species	Percent cover	Height (m)	Comments
Start	End				
Transect V4, 6-Sep-2001					
0	3	*Bromus* spp.	70		Gate to marsh edge
3	6.3	Bare ground	80		
		Salicornia virginica	20		
6.3	33	*Salicornia europaea*	25		
		Bare ground	70		
		Salicornia virginica	3		
		Spergularia marina	2		
33	40.5	Channel	100		
40.5	61	*Salicornia virginica*	5		
		Salicornia europaea	65		
		Spartina foliosa	5		Indeterminant hybrids possible
		Spergularia marina	2		
		Bare ground	25		
61	73	Bare ground	100		
73	80	*Spartina foliosa*	5		Indeterminant hybrids possible
		Salicornia virginica	5		
		Grindelia stricta	5		
		Salicornia europaea	80		
		Bare ground	5		
80	82.7	Bare ground	50		
		Bromus spp.	50		
Bare Ground (excluding channel):			**53%**		
Transect V4, 3-Jan-2001 (2000 Survey)					
0	3	*Bromus* spp.	70		Gate edge to marsh edge
3	6.3	Bare ground	100		Marsh edge
6.3	15.3	*Salicornia europaea*	40	0.2	Dead (annual), constructed high marsh to slope break
		Bare ground	55		
		Distichlis spicata	2	0.2	
		Salicornia virginica	3		
		Spergularia marina	2	0.05	
15.3	33	*Salicornia europaea*	10	0.2	Constructed low marsh to channel
		Spergularia marina	2		
		Bare ground	85		Algae throughout
33	40.5	Bare ground/ open water	0		Channel
40.5	49	*Salicornia virginica*	5	0.2	Constructed high marsh to end
		Salicornia europaea	20	0.2	
		Spartina foliosa	5	0.3	Indeterminant hybrids possible.
		Spartina alterniflora	2	1	Most plants were recently pulled from ground by others
		Spergularia marina	2		
		Bare ground	65		Algae throughout
49	56.8	Open water/ bare ground	100		Pockets of water
56.8	64.3	*Salicornia europaea*	20		
		Spartina foliosa	5		Indeterminant hybrids possible
		Salicornia virginica	1		
		Bare ground	75		Algae throughout
64.3	73	*Salicornia europaea*	5		
		Salicornia virginica	1		
		Bare ground	95		Water 2-3" no algae
73	75	*Spartina foliosa*	30	1	Indeterminant hybrids possible
		Salicornia virginica	30	0.2	
		Grindelia stricta	5	0.2	
		Jaumea carnosa	5	0.05	
		Spartina alterniflora	20	0.4	Indeterminant hybrids possible

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)				Height	
Start	End	Species	Percent cover	(m)	Comments
		Salicornia europaea	10	0.2	
75	77.8	Bare ground	90		
		Cotula coronopifolia	5	0.02	Sprouts
		Unknown grass	5	0.05	Brome?
77.8	80	*Bromus* spp.	100		Fence
Bare Ground (excluding channel):			**66%**		
Transect V5, 6-Oct-2003					
0	41	*Salicornia europaea*	80		
		Spartina spp.	8		Indeterminant hybrids possible
		Salicornia virginica	5		
		Bare ground	7		
41	46.5	Channel	100		
46.5	170	*Jaumea carnosa*	2		
		Salicornia europaea	50		
		Spartina spp.	10		Indeterminant hybrids possible
		Salicornia virginica	5		
		Bare ground	35		
170	183	Channel	100		
183	232	*Spartina* spp.	5		Indeterminant hybrids possible
		Salicornia virginica	5		
		Bare ground	5		
		Salicornia europaea	85		
232	240	*Frankenia salina*	5		
		Salicornia virginica	50		
		Spartina spp.	45		Indeterminant hybrids possible
Bare Ground (excluding channel):			**22%**		
Transect V5, 5-Nov-2002					From SP-8 (west end) through SP-10 to marsh edge (east end)
0	41	*Salicornia europaea*	80		
		Salicornia virginica	5		
		Spartina spp.	2		Indeterminant hybrids possible
		Bare ground	15		
41	46.5	Channel	100		
46.5	84	*Salicornia europaea*	85		
		Spartina spp.	3		Indeterminant hybrids possible
		Bare ground	15		
84	161	*Salicornia europaea*	45		
		Spartina spp.	3		Indeterminant hybrids possible
		Salicornia virginica	2		
		Bare ground	50		
161	170	Bare ground	20		
		Salicornia europaea	75		
		Spartina spp.	5		Indeterminant hybrids possible
170	183	Channel	100		
183	235	*Salicornia europaea*	75	0.20 m	
		Spergularia marina	1		
		Spartina spp.	3		Indeterminant hybrids possible
		Salicornia virginica	5		
		Bare ground	15		
235	240	*Salicornia virginica*	75		Bank
		Spartina spp.	10		Indeterminant hybrids possible. Bank
		Bromus spp.	5		Bank
Bare Ground (excluding channel):			**27%**		

Table 6
Tidal Marsh Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)					
Start	**End**	**Species**	**Percent cover**	**Height (m)**	**Comments**
Transect V5, 6-Sep-2001					
0	41	*Salicornia europaea*	75		
		Salicornia virginica	5		
		Spergularia marina	1		
		Bare ground	20		
41	46.5	Channel	100		
46.5	83	Bare ground	45		
		Salicornia europaea	55		
83	163	Bare ground	80		
		Salicornia europaea	20		
163	170	*Salicornia europaea*	65		
		Spartina foliosa	30		Indeterminant hybrids possible
170	183	Channel	100		
183	227	*Salicornia europaea*	65		
		Salicornia virginica	5		
		Spartina foliosa	5		Indeterminant hybrids possible
		Bare ground	25		
227	233	*Salicornia europaea*	45		
		Salicornia virginica	45		
		Spartina foliosa	5		Indeterminant hybrids possible
233	236	Bare ground	100		
236	239	*Bromus* spp.	60		
Bare Ground (excluding channel):			**47%**		
Transect V5, 3-Jan-2001 (2000 Survey)					
0	21.2	*Salicornia europaea*	5	0.2	Slightly elavated bench, constructed high and low marsh to channel
		Salicornia virginica	5	0.4	
		Spergularia marina	1	0.05	
		Bare ground	90		Algae
41	46.5	Channel	100		Channel
46.5	83	Bare ground	97		Algae, constructed low marsh to next channel
		Salicornia europaea	3		
83	163	Bare ground	95		2" water
		Salicornia europaea	5		Red Pvc Pipe@163
163	170	*Salicornia europaea*	10		
		Spartina foliosa	5		Indeterminant hybrids possible
		Bare ground	85		Algae
170	183	Channel	100		
183	200	*Salicornia europaea*	50	0.2	Constructed high marsh to end
		Salicornia virginica	4		
		Spartina foliosa	1		Indeterminant hybrids possible
		Bare ground	50		Algae
200	227	*Salicornia europaea*	10		
		Spartina foliosa	2		Indeterminant hybrids possible
		Bare ground	90		Water 3"
227	233	*Salicornia europaea*	45	0.2	
		Salicornia virginica	45	0.3	
		Spartina foliosa	5	0.4	Indeterminant hybrids possible
		Distichlis spicata	2		
233	236	Bare ground	100		Litter
236	239	*Bromus spp.*	60		
		Hirschfeldia incana	30		Mustard
239		Fence			2m south of "keep out" sign
Bare Ground (excluding channel):			**78%**		

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)			Percent	Height	
Start	**End**	**Species**	**cover**	**(m)**	**Comments**
2003 SURVEY, 14-May-03					
Pond 1					
T1-1		**Transect location = 94 degrees E. from rebar**			Total transect distance = 77.2 m
0	3.2	*Anagallis arvensis*	5		
		Cotula coronopifolia	1		
		Melilotus indica	35		
		Plantago coronopus	50		
		Polypogon monspeliensis	10		
3.2	9.2	*Atriplex triangularis*	5		
		Carex spp.	5		
		Cotula coronopifolia	1		
		Crypsis vaginiflora	35		
		Lythrum hyssopifolium	7		
		Bare ground	50		
9.2	77.2	Pond water			
% Bare ground in vegetated section of transect:			**33%**		
T1-2		**Transect location = 244 degrees W. from rebar**			Total transect distance = 73 m.
0	13.3	*Cotula coronopifolia*	5		
		Frankenia salina	5		
		Melilotus indica	5		
		Plantago coronopus	30		
		Spergularia marina	10		
		Bare ground	40		
13.3	16.9	*Atriplex triangularis*	10		
		Crypsis vaginiflora	15		
		Bare Ground	75		
16.9	73	Pond water			
% Bare ground in vegetated section of transect:			**47%**		
Pond 2					Water depth at staff gauge = 2.6 ft.
T2-1		**Transect location = 238 degrees SW from rebar**			Total transect distance = 85 m.
0	4.5	*Melilotus indica*	50		
		Ballardia trixago	2		
		Geranium dissectum	5		
		Hordeum marinum gussoneanum	10		
		Lolium multiflorum	10		
		Lotus corniculatus	10		
		Trifolium microcephalum	3		
4.5	10	*Cotula coronopifolia*	5		
		Crypsis vaginiflora	15		
		Lythrum hyssopifolia	25		
		Melilotus indica	1		
		Plantago coronopus	10		
		Unknown #1	30		very small no flower
		Bare Ground	15		
10	85	Pond water			
% Bare ground in vegetated section of transect:			**8%**		
T2-2		**Transect location = 340 degrees N. from rebar**			Total transect distance = 88 m.
0	19	*Hordeum marinum gussoneanum*	10		
		Lolium multiflorum	25		
		Lotus corniculatus	30		
		Melilotus indica	20		

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m) Start	End	Species	Percent cover	Height (m)	Comments
		Plantago lanceolata	5		
		Polypogon monspeliensis	5		
		Vulpia myuros	10		
19	27	*Carex* spp.	5		
		Cotula coronopifolia	5		
		Lythrum hyssopifolia	30		
		Plantago coronopus	10		
		Unknown #1	30		
		Bare Ground	20		
27	88	Pond water			
% Bare ground in vegetated section of transect:			**6%**		
Pond 3					Water depth on staff gauge = 1.4 ft.
T3-1		**Transect location = 310 degrees NW from rebar**			Total transect distance = 50.9 m.
0	13.1	*Bellardia trixago*	1		
		Hordeum marinum gussoneanum	5		
		Lolium multiflorum	20		
		Lotus corniculatus	25		
		Melilotus indica	25		
		Vulpia myuros	25		
13.1	22.4	*Carex* spp.	30		
		Cotula coronopifolia	5		
		Crypsis vaginiflora	5		
		Lythrum hyssopifolia	5		
		Plantago coronopus	5		
		Salicornia virginica	5		
		Typha latifolia	5		
		Unknown #1	5		
		Bare Ground	35		
22.4	50.9	Pond water			
% Bare ground in vegetated section of transect:			**15%**		
T3-2		**Transect location = 94 degrees E from rebar**			Total transect distance = 63.6 m.
0	7.36	*Bellardia trixago*	1		
		Bromus hordeaceus	5		
		Hordeum marinum gussoneanum	5		
		Lolium multiflorum	10		
		Lotus corniculatus	15		
		Lupinus bicolor	5		
		Melilotus indica	50		
		Plantago lanceolata	5		
		Sonchus spp.	5		
7.3	12.8	*Cotula coronopifolia*	20		
		Melilotus indica	10		
		Plantago coronopus	30		
		Polypogon monspeliensis	10		
		Bare Ground	20		
12.8	18.5	*Carex* spp.	40		
		Bare Ground	60		
18.5	63.6	Pond water			
% Bare ground in vegetated section of transect:			**24%**		
2002 SURVEY, 24-April-02					
Pond 1					Water depth at staff gauge = 2.3 ft.

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)		Species	Percent cover	Height (m)	Comments
Start	**End**				
T1-1		**Transect location = 94 degrees E. from rebar**			Total transect distance = 77.2 m.
0	3.2	*Cotula coronopifolia*	40	0.01	Very small
		Juncus bufonius	5	0.01	Very small
		Plantago spp.	5	0.02	Very small
		Anagallis arvensis	5	0.02	
		Melilotus indica	1	0.07	
		Bare ground	45		
3.2	6	*Crypsis vaginiflora*	10	0.01	
		Carex spp.	1	0.02	Too small to identify species
		Cotula coronopifolia	5	0.01	
		Spergularia marina	5	0.01	Small white flower
		Lythrum hyssopifolium	2	0.01	
		Bare ground	75		
6	77.2	Pond water			
% Bare ground in vegetated section of transect:			**59%**		
T1-2		**Transect location = 244 degrees W. from rebar**			Total transect distance = 73 m.
0	14.7	*Melilotus indica*	2	0.04	Mostly bare
		Plantago spp.	5	0.01	Small sprouts
		Cotula coronopifolia	5	0.01	
		Frankenia salina	1	0.04	
		Cynodon dactylon	1	0.01	
		Bare ground	85		
		Spergularia marina	1	0.01	
14.7	73	Pond water			
% Bare ground in vegetated section of transect:			**85%**		
Pond 2					Water depth at staff gauge = 2.86 ft.
T2-1		**Transect location = 238 degrees SW from rebar**			Total transect distance = 85 m.
0	4.5	*Lotus corniculatus*	10		Misidentified this in 2001 as scotch broom
		Lythrum hyssopifolium	5		
		Plantago lanceolata	15		
		Hordeum brachyantherum	10		
		Unknown species #1	15		Small white flower
		Nassela spp.	2		Small bunch grass; no flower.
		Cynodon dactylon	10		
		Bare ground	40		
		Carex spp.	2		
4.5	12	*Cynodon dactylon*	5		
		Carex spp.	1		
		Lythrum hyssopifolium	5		
		Bare ground	90		
12	85	Pond water			
% Bare ground in vegetated section of transect:			**71%**		
T2-2		**Transect location = 340 degrees N. from rebar**			Total transect distance = 88 m.
0	19	*Lotus corniculatus*	20		Weedy
		Melilotus indica	20		
		Hordeum brachyantherum	50		
		Hordeum marinum ssp. *gussoneanum*	10		
		Lythrum hyssopifolium	5		
		Bare ground	5		

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)		Species	Percent cover	Height (m)	Comments
Start	End				
19	30	*Lythrum hyssopifolium*	3		Upper water level is at 19 m along transect
		Spergularia marina	2		
		Bare ground	95		
30	88	Pond water			
% Bare ground in vegetated section of transect:			**38%**		
Pond 3					Water depth on staff gauge = 1.5 ft.
T3-1		**Transect location = 310 degrees NW from rebar**			Total transect distance = 50.9 m.
0	12.2	*Hordeum brachyantherum*	70		
		Lotus corniculatus	10		
		Hordeum marinum ssp. *gussoneanum*	30		
		Bromus hordeaceus	5		
		Melilotus indica	5		
		Lolium perenne	5		
12.2	19.4	*Carex* spp.	25		
		Bare ground	65		
		Lythrum hyssopifolium	5		
		Unknown species	5		
19.4	50.9	Pond water			
% Bare ground in vegetated section of transect:			**24%**		
T3-2		**Transect location = 94 degrees E from rebar**			Total transect distance = 63.6 m.
0	7	*Hordeum brachyantherum*	40	0.1	
		Lupinus spp.	20	0.1	
		Melilotus indica	15		
		Hordeum marinum ssp. *gussoneanum*	15		
		Vulpia myuros	10		
7	12	*Cotula coronopifolia*	25		Nesting avocets
		Plantago lanceolata	25		
		Bare ground	50		
		Picris echioides	1		
12	14.8	*Carex* spp.	20	0.1	
		Bare ground	80		
14.8	63.6	Pond water			
% Bare ground in vegetated section of transect:			**32%**		
2001 SURVEY #1, 22-Mar-01					
Pond 1					Depth at staff = 2.21 ft.
T1-1		**Transect location = 94 degrees E. from rebar**			Total transect distance = 77.2 m.
0	7.5	*Melilotus indica*	5	0.4	
		Crypsis vaginiflora	10	0.05	
		Lythrum hyssopifolia	1	0.1	
		Cotula coronopifolia	5	0.2	
		Polypogon monspeliensis	10	0.1	
		Juncus bufonius	10	0.1	
		Unknown #1	10	0.05	Too small to I.D.
		Bare ground	50		
7.5	77.2	Open water			Edge of water to staff gauge
% Bare ground in vegetated section of transect:			**50%**		
T1-2		**Transect location = 244 degrees W. from rebar**			Total transect distance = 73 m.
0	15.9	*Crypsis vaginiflora*	5		
		Cotula coronopifolia	10		

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)			Percent	Height	
Start	**End**	**Species**	**cover**	**(m)**	**Comments**
		Frankenia salina	2		
		Unknown #1	15		No flower
		Melilotus indica	5		
		Spergularia marina	5		Purple
		Bare ground	55		
15.9	73	Open water			
% Bare ground in vegetated section of transect:			**55%**		
Pond 2					Depth at staff = 2.76 ft.
T2-1		**Transect location = 238 degrees SW from rebar**			Total transect distance = 85 m.
0	7	*Melilotus indica*	70	0.4	
		Nassella spp.	5	0.2	Small clump, possibly *N. cernua*
		Polypogon monspeliensis	2	0.1	
		Crypsis vaginiflora	2	0.05	
		Cotula coronopifolia	1	0.02	
		Bare ground	10		
7	13.6	*Melilotus indica*	5		
		Cotula coronopifolia	50	0.01	Small sprouts
		Nassella spp.	2		
		Spergularia marina	1		
		Cyperus involucratus	2		Dead
		Bare ground	45		
13.6	85	Open water			
% Bare ground in vegetated section of transect:			**27%**		
T2-2		**Transect location = 340 degrees N. from rebar**			Total transect distance = 88 m.
0	12	*Bromus hordeaceus*	3		
		Lolium multiflorum	2		
		Unknown grass #1	10		
		Genista monspessulana	70		French broom
		Crypis vaginiflora	5		
		Sonchus spp.	1		Sprout
		Polypogon monspeliensis	5		
		Bare ground	5		
		Hordeum brachyantherum	2		
12	22.6	*Cotula coronopifolia*	5		
		Melilotus indica	5		
		Lythrum hyssopifolia	15		
		Polypogon monspeliensis	5		
		Unknown grass #1	10		
		Nassella spp.	1		No floret
		Crypis vaginiflora	10		
		Bare ground	50		
22.6	88	Open Water			
% Bare ground in vegetated section of transect:			**26%**		
Pond 3					Depth at staff = 1.72 ft.
T3-1		**Transect location = 310 degrees NW from rebar**			Total transect distance = 50.9 m.
0	12.1	*Hordeum murinum glaucum*	45	0.1	
		Unknown grass #1	35	0.2	
		Picris echiodes	1	0.05	
		Plantago lanceolata	1	0.1	
		Melilotus indica	5	0.1	
		Lythrum hyssopifolia	1	0.05	

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)			Percent	Height	
Start	**End**	**Species**	**cover**	**(m)**	**Comments**
		Edge Pool Species	10	0.02	Too small to I.D.
12.1	15	*Scirpus robustus*	5	3	
		Typha latifola	10	0.5	
15	50.9	Open Water			
% Bare ground in vegetated section of transect:			**0%**		
T3-2		**Transect location = 94 degrees E from rebar**			Total transect distance = 63.6 m.
0	7.5	*Melilotus indica*	60		
		Hordeum murinum	5		
		Picris echiodes	2		
		Polypogon monspeliensis	10		
		Unknown grass #1	25		
7.5	13	*Melilotus indica*	10	0.1	
		Scirpus robustus	10	0.2	
		Typha latifolia	10	0.3	
		Salicornia virginica	2	0.1	
		Edge Pool Species	5	0.1	Approx. 3 species. Too small to I.D.
		Crypsis vaginiflora	2	0.02	
		Lythrum hyssopifolium	2	0.05	
		Bare Ground	50		
		Polypogon monspeliensis	5	0.03	
13	63.6	Open water			
% Bare ground in vegetated section of transect:			**21%**		
2001 SURVEY #2, 26-Apr-01					
Pond 1					Depth at staff = 1.76 ft.
T1-1		**Transect location = 94 degrees E. from rebar**			Total transect distance = 77.2 m.
0	7	*Melilotus indica*	10	0.2	
		Bare ground	10		
		Crypsis vaginiflora	25	0.02	
		Anagallis arvensis	5	0.05	
		Cotula coronopifolia	15	0.02	
		Plantago lanceolata	35	0.02	
7	11	Bare ground	95		
		Cynodon dactylon	5	0.01	
11	77.2	Open water			
% Bare ground in vegetated section of transect:			**41%**		
T1-2		**Transect location = 244 degrees W. from rebar**			Total transect distance = 73 m.
0	15.9	*Atriplex triangularis*	2		
		Plantago lanceolata	20		
		Frankenia salina	5		
		Melilotus indica	10		No flower
		Spergularia marina	10		Purple
		Bare ground	45		
15.9	73	Open water			
% Bare ground in vegetated section of transect:			**45%**		
Pond 2					Depth at staff = 2.29 ft.
T2-1		**Transect location = 238 degrees SW from rebar**			Total transect distance = 85 m.
0	12.3	*Melilotus indica*	50	0.5	
		Anagalis arvensis	5	0.05	
		Plantago lanceolata	5	0.05	
		Taraxicum officinale	2	0.1	

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)			Percent	Height	
Start	End	Species	cover	(m)	Comments
		Cotula coronopifolia	2	0.05	
		Nassella spp.	3	0.2	
		Cyperus involucrata	3	0.2	
		Genista monspessulana	5	0.1	
		Gnaphalium spp.	1	0.05	
		Lythrum hyssopifolim	1	0.05	
		Cynodon dactylon	3	0.02	
		Bare ground	10		
		Geranium dissectum	1		
12.3	19.5	*Cyperus involucrata*	1		
		Cynodon dactylon	10		
		Unknown sp.	10		
		Bare Ground	79		
19.5	85	Open water			
% Bare ground in vegetated section of transect:			**35%**		
T2-2		**Transect location = 340 degrees N. from rebar**			Total transect distance = 88 m.
0	14	*Hordeum brachyantherum*	5		
		Vulpia myuros	5		
		Hordeum murinum ssp. glaucum	5		
		Melilotus indica	65		
		Genista monspessulana	15		
		Plantago lanceolata	5		
14	36.5	*Genista monspessulana*	5		
		Plantago lanceolata	5		
		Cotula coronopifolia	5		
		Lythrum hyssopifolia	20		
		Unknown sp.	20		
		Bare ground	45		
36.5	88	Open water			
% Bare ground in vegetated section of transect:			**28%**		
Pond 3					Depth at staff = 1.30 ft.
T3-1		**Transect location =310 degrees NW from rebar**			Total transect distance = 50.9 m.
0	11	*Hordeum murinum ssp. glaucum*	25	0.1	
		Hordeum brachyantherum	25	0.5	
		Lolium perenne	25	0.3	
		Melilotus indica	15	0.3	
		Bromus hordeaceus	5	0.2	
		Genista monspessulana	5		
11	19	*Melilotus indica*	5		
		Unknown grass	10		
		Scirpus robustus	15	0.2	
		Typha latifola	10	0.2	
		Hordeum murinum glaucum	5		
		Cotula coronopifolia	10		
		Bare ground	35		
19	50.9	Open water			
% Bare ground in vegetated section of transect:			**6%**		
T3-2		**Transect location = 94 degrees E from rebar**			Total transect distance = 63.6 m.
0	7.4	*Vulpia myuros*	20		
		Hordeum brachyantherum	20		
		Picris echiodes	5		

Table 7
Seasonal Wetland and Pond Vegetation Transects, 2000-2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Distance (m)			Percent	Height	
Start	**End**	**Species**	**cover**	**(m)**	**Comments**
		Lupinus spp.	5		
		Genista monspessulana	5		
		Lolium perenne	15		
		Bromus hordeaceus	5		
		Geranium dissectum	20	0.1	
7.4	TBV**	*Melilotus indica*	10		
		Plantago lanceolata	10		
		Scirpus robustus	10		
		Cotula coronopifolia	10		
		Unknown grass	5		Small *Polypogon* spp.?
		Salicornia virginica	5		
		Bare Ground	50		
TBV**	63.6	Open water			
% Bare ground in vegetated section of transect:			**TBV****		
2000 Survey, 2-Nov-00					
		Transect location = continuation of tidal wetland Transect V3 (see Figure 2)			
0	168.6				Tidal wetland -- See Table 8.
168.6	200	*Plantago coronopus*	10		
		Frankenia salina	1		Road to edge of pond 2
		Genista monspessulana	5		
		Melilotus indica	5		
		Picris echiodes	1		
		Bare ground	80		
		Heliotropium curassavicum	1		
200	217	Bare ground	70		
		Plantago coronopus	5		
		Lythrum hyssopifolium	5		
		Crypsis vaginiflora	20		
217	290	Pond/ Open water	60		pond w/ water 230-255
		Bare ground	38		
		Crypsis vaginiflora	2		
290	331	*Lythrum hyssopifolium*	10		to edge of algae matting
		Scirpus robustus	5		
		Crypsis vaginiflora	10		
		Bare ground	75		
331	380	*Plantago coronopus*	70		Species to fence
		Melilotus indica	10		
		Picris echioedes	2		
		Salsola tragus	1		
% Bare ground in vegetated section of transect:			**25%**		

Notes:

* The rebar at T2 which indicates transect start could not be found, so the transect is based on angle and distance from staff gauge consistent with previous transect surveys.

** To be verified.

*** All surveys by Vir McCoy.

Table 8
Seasonal Wetland Vegetation Percent Cover Summary, 2001 - 2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

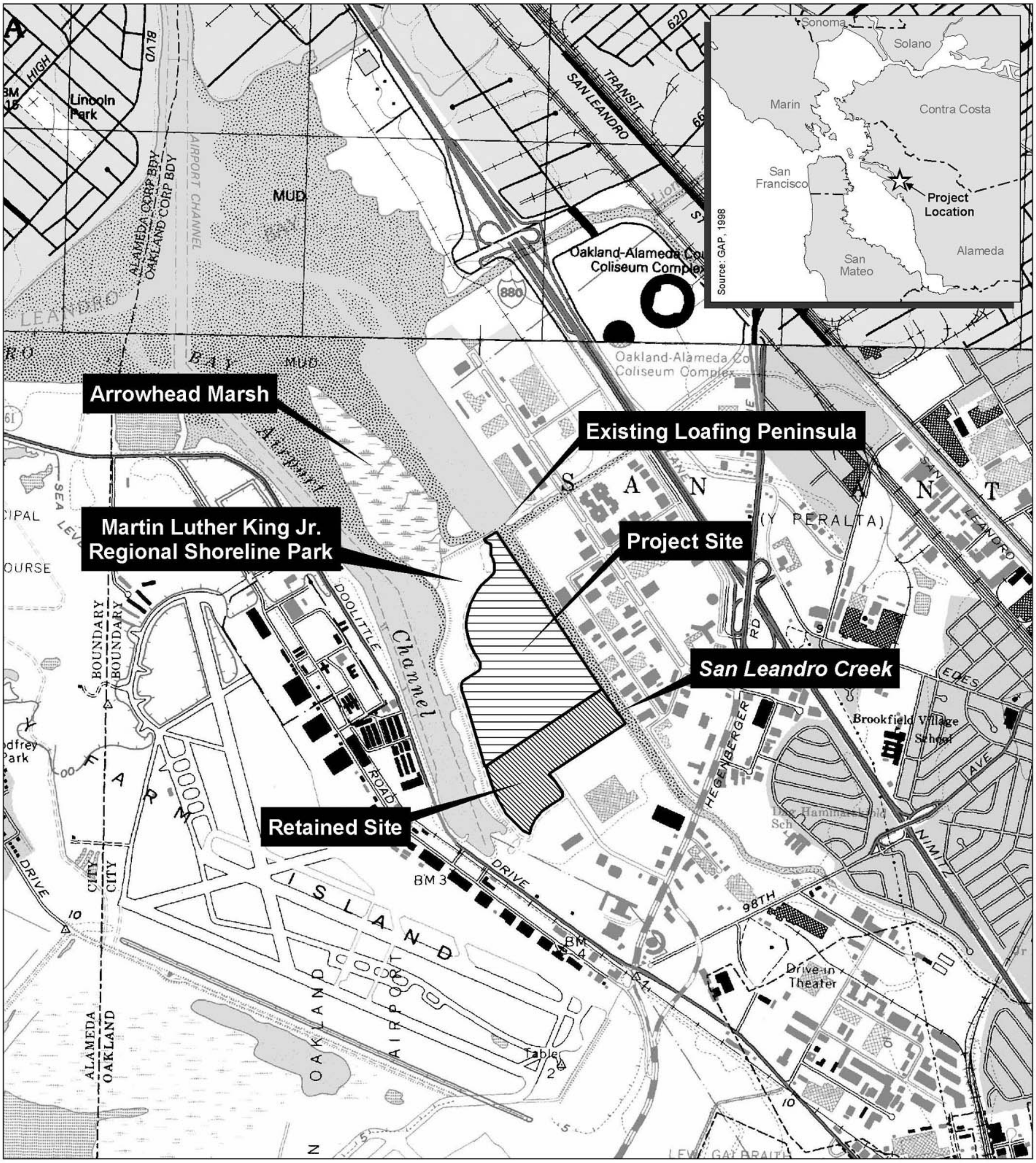
	Percent cover outside ponds		
Transect	**2003**	**2002**	**2001***
T1-1	**67%**	**41%**	**54%**
T1-2	**53%**	**15%**	**50%**
T2-1	**92%**	**29%**	**69%**
T2-2	**94%**	**62%**	**73%**
T3-1	**85%**	**76%**	**97%**
T3-2	**76%**	**68%**	**79%**

Note: Surveys performed on May 14, 2003; April 24, 2002; March 22, 2001; April 26, 2001.
* 2001 values are averaged from the two 2001 surveys.

Table 9
Relative Shorebird Use of Habitat Sub-areas at the Project, 1998-2003.
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California

Tidal Stage	Intertidal Pond	Marsh Plain	Channels	Islands	Seasonal Ponds
Incoming	high	high	low	low	low
High	moderate	moderate	low	moderate	moderate
Outgoing	moderate	high	low	low	low
Low	low	low	low	low	low

Figures



N

0 500 1,000 Meters

1:24,000 (1in = 2000ft, at Letter-size)

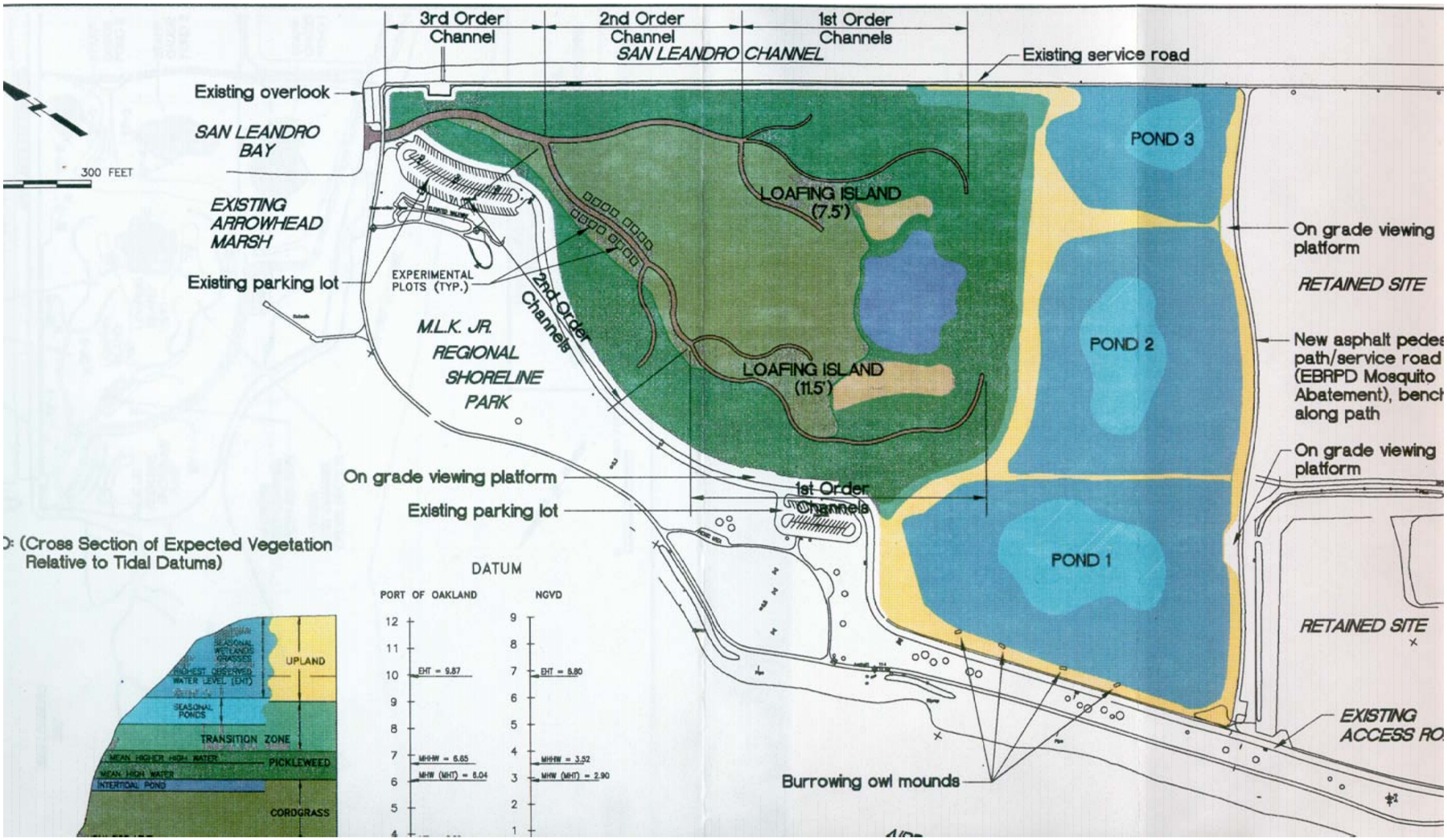
0 1,000 2,000 4,000 Feet

Data Sources: USGS (San Leandro & Oakland East Quads), 1959 & 1996
Map File: Site_1044_LT-P_010204.mxd

WETLANDS AND WATER RESOURCES

SITE VICINITY MAP
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004 | Project No. 1044 | **Figure 1**

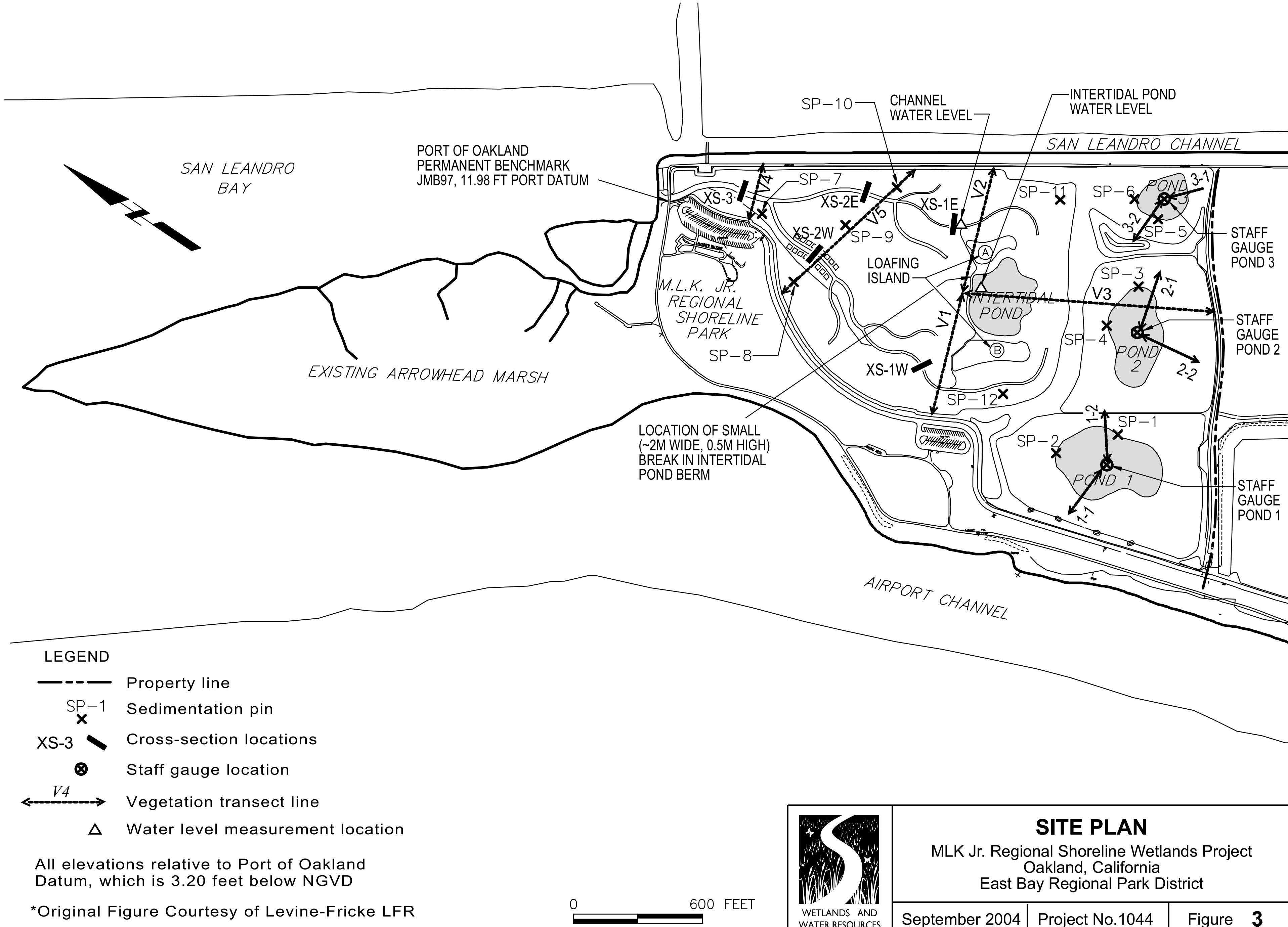


WETLANDS AND WATER RESOURCES

RESTORATION DESIGN

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004	Project No. 1044	Figure 2



WETLANDS AND WATER RESOURCES

SITE PLAN

MLK Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

September 2004	Project No.1044	Figure 3

1044_MLK-5yr_Fig3_2004-0902.ai

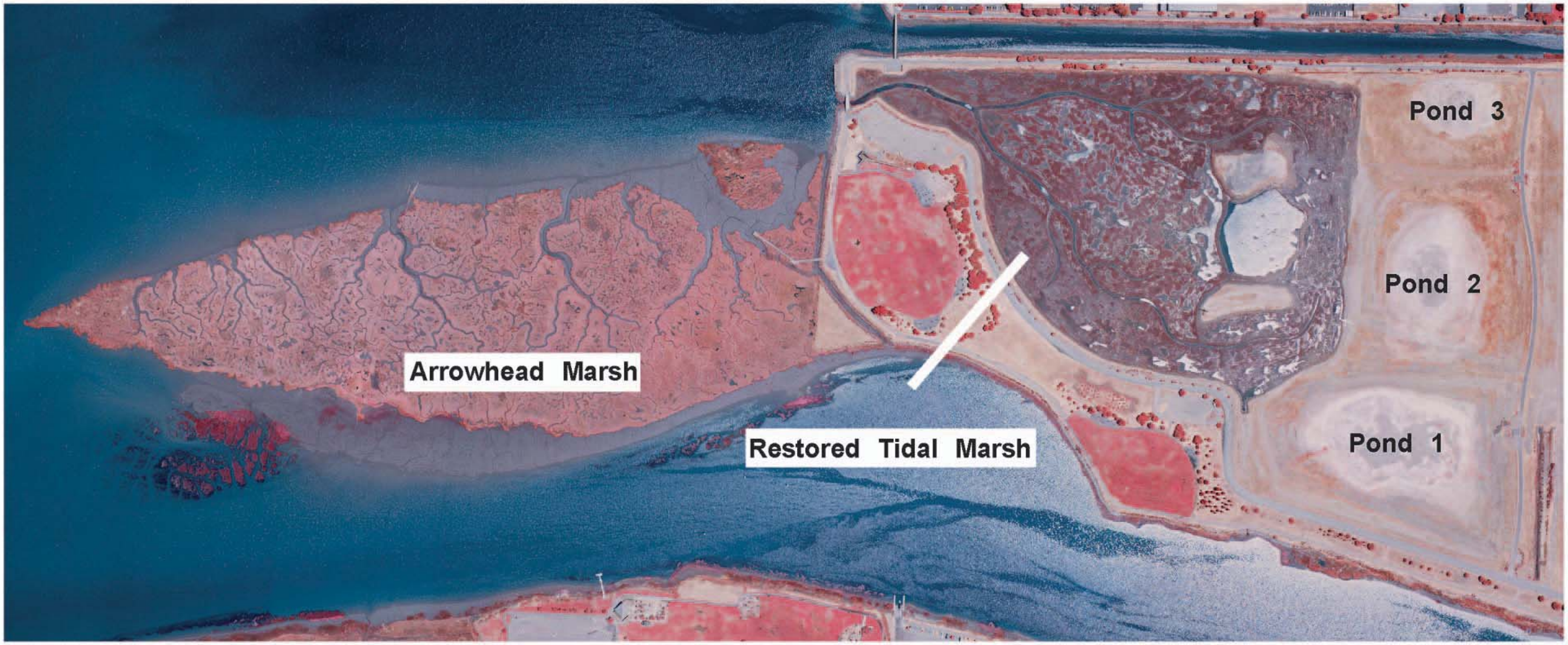
0 600 FEET

Photo courtesy of Spartina Control Group, California State Coastal Conservancy
Orthorectification courtesy of San Francisco Estuary Institute

WETLANDS AND WATER RESOURCES

Color Infrared Aerial Photograph
25 September 2000
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004	Project No.1044	Figure **4**



Color Infrared Aerial Photograph
24 July 2001

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

WETLANDS AND WATER RESOURCES

September 2004	Project No.1044	Figure **5**

0 162.5 325 Meters

1:7,800 (1" = 650', at Letter-size)

0 325 650 1,300 Feet

N

WETLANDS AND WATER RESOURCES

COLOR INFRARED AERIAL PHOTOGRAPH
26 AUGUST 2002

Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

September 2004 | Project No. 1035 | **Figure 6**

Data Sources: Air Flight Service (photo date 08/26/02)
Map File: Figure-12_02_1044_11-22-02.mxd

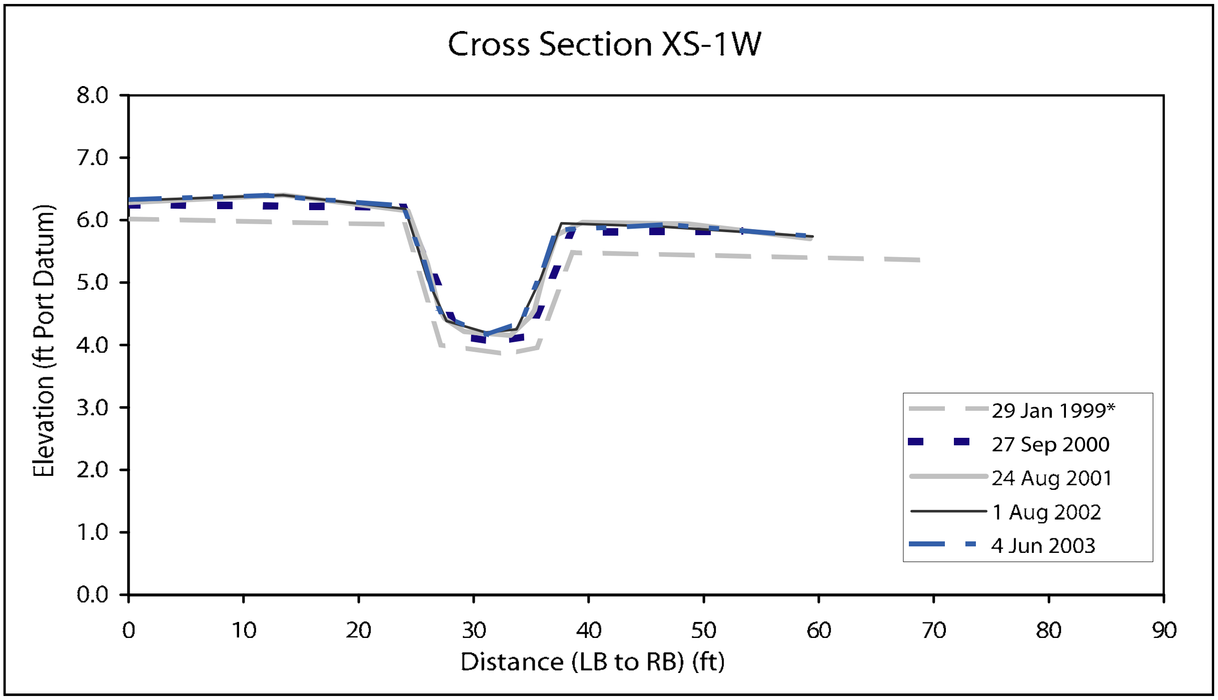
Data Sources: WWR, 2003; HJW (photo date 08/29/03)
Map File: Photo-Map_1044_A-L_111003.mxd

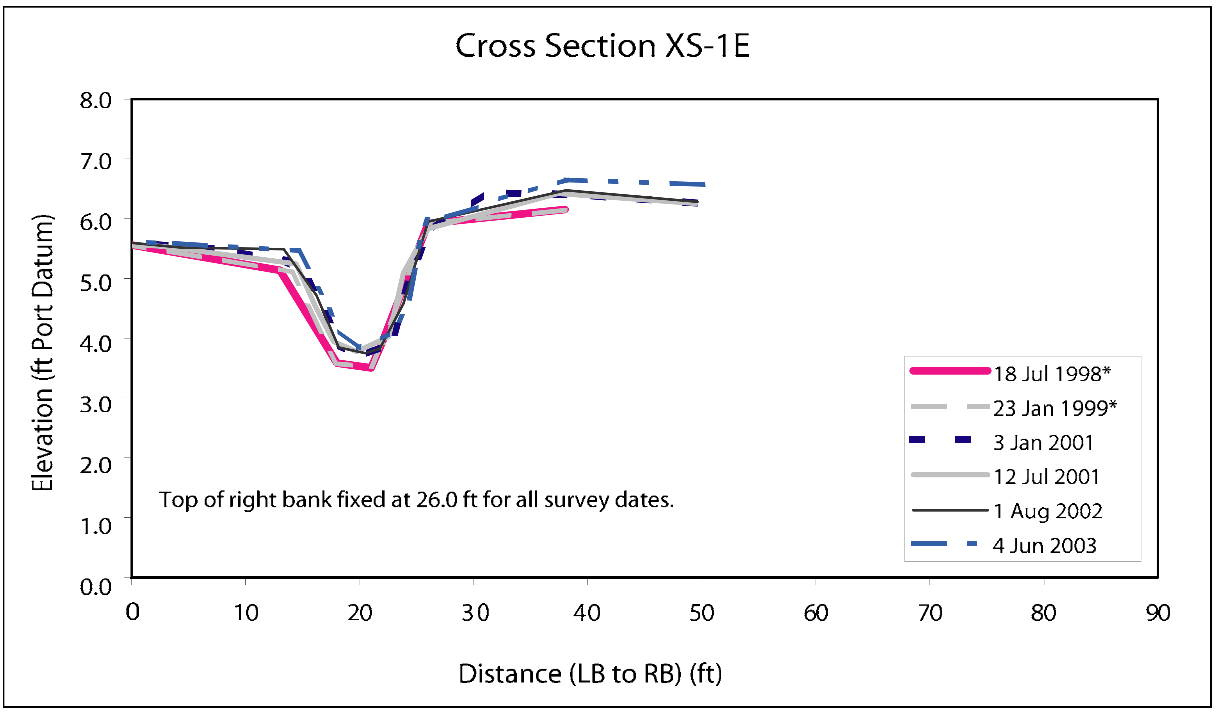
WETLANDS AND WATER RESOURCES

COLOR INFRARED AERIAL PHOTOGRAPH
19 AUGUST 2003

Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

September 2004	Project No. 1044	**Figure 7**





Notes:
* Previous surveys from LFR 1999a. Data not validated.

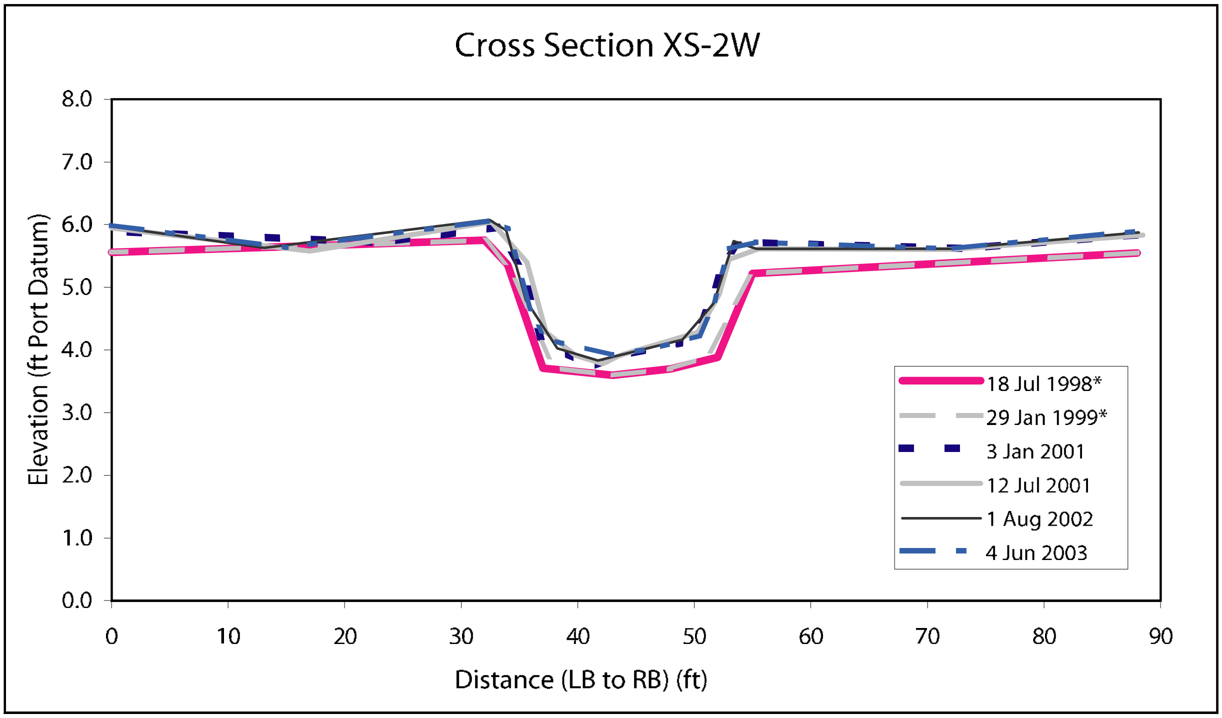
WETLANDS AND WATER RESOURCES

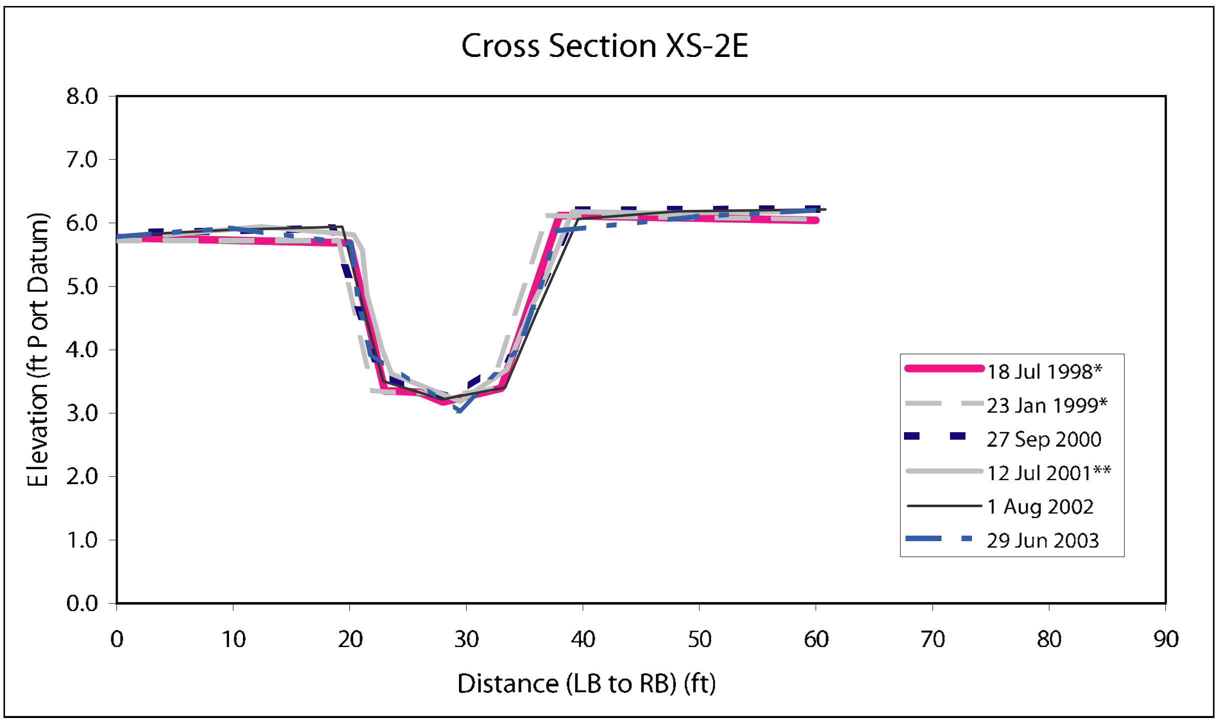
FIRST-ORDER CHANNEL CROSS SECTIONS, 1998 - 2003

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004	Project No.1044	Figure **8**

1044_Fig 08_First Order XS_2004-0902





Notes:

* Previous surveys from LFR 1999a. Data not validated.

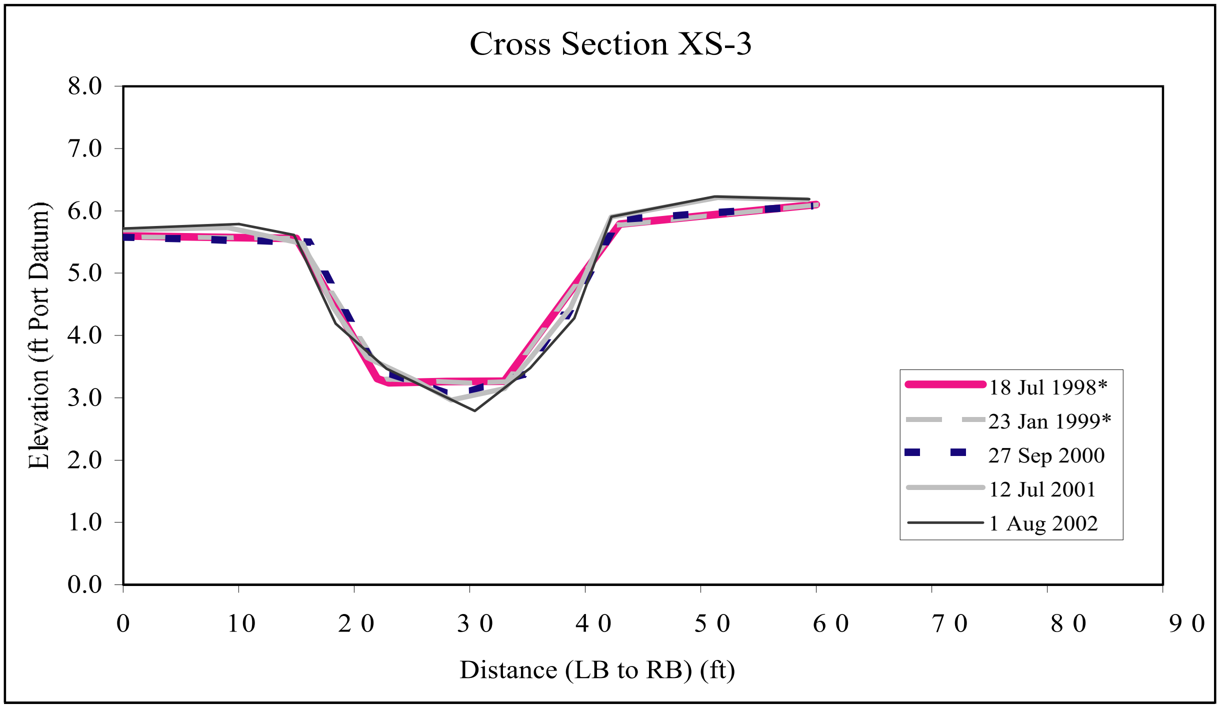
** Right bank (RB) of July 2001 survey was aligned with RB of January 2001 survey in order to adjust for different transect endpoints.

WETLANDS AND WATER RESOURCES

SECOND-ORDER CHANNEL CROSS SECTIONS, 1998 - 2003

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004 | Project No.1044 | Figure **9**



Notes:
* Previous surveys from LFR 1999a. Data not validated.

WETLANDS AND WATER RESOURCES

THIRD-ORDER CHANNEL CROSS SECTION, 1998 - 2003

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004	Project No.1044	Figure **10**

1044_Fig 10_Third-Order XS_2004-0902

2003 Air Photo, No Overlay
Photo Date: 08/29/03

Data Sources: WWR, 2003; Levine-Fricke, 1998 (published 1999)
Map File: Channels_98-03_1044_B-L_072704.mxd

1998 vs 2003 Channel Networks
Photo Date: 08/29/03

Legend

- 1998 Channel Network
- 2003 Channel Network
- Site Boundary

Note: Channel bank from 1998 based on schematic of a different scale and with differing rectification method, therefore overlay of channel network does not provide quantitative measure of change.

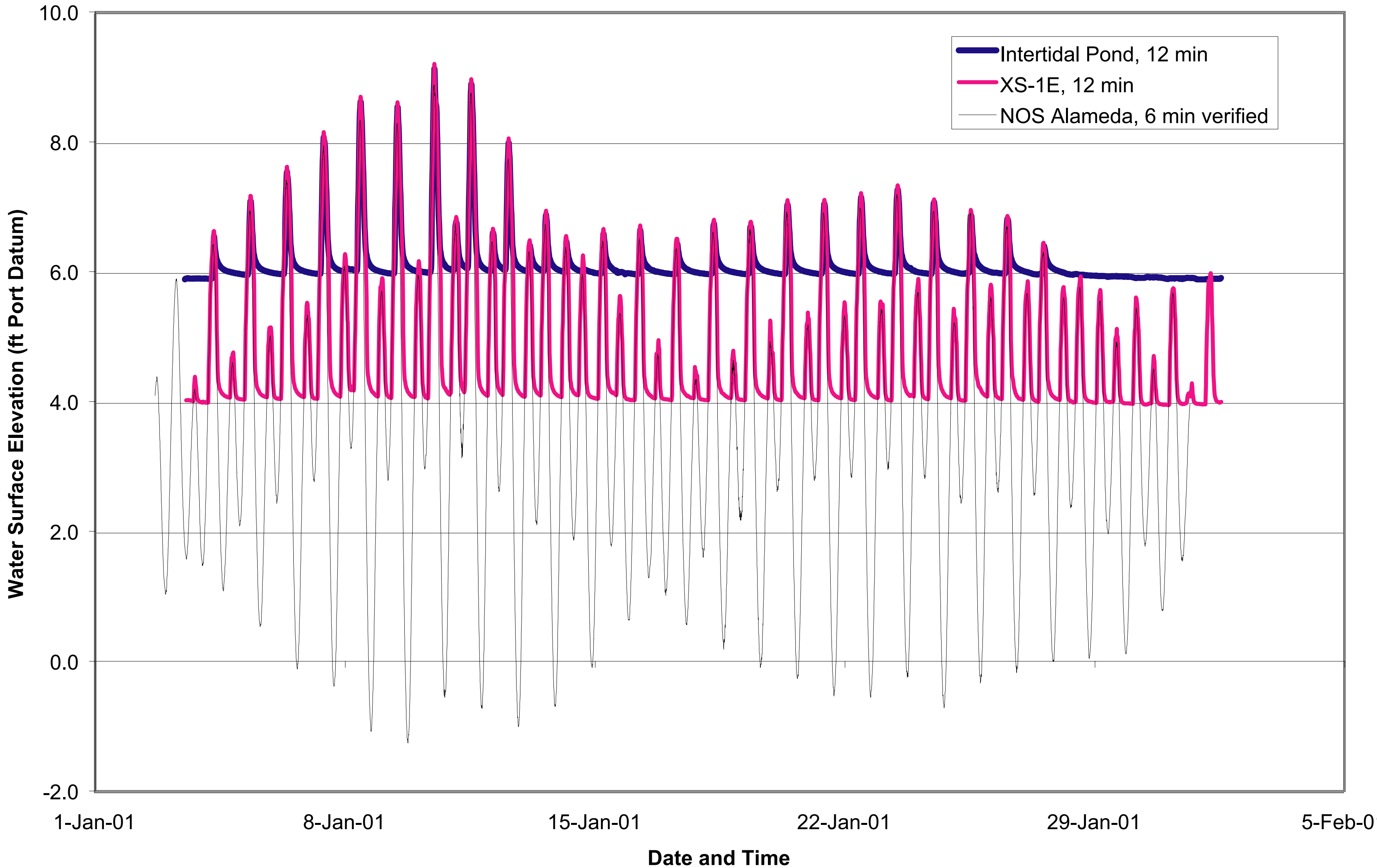
1:3,000
(1in = 250ft at tabloid layout)
0 125 250 500 Feet
(Scale applies to each frame individually)
0 125 250 Meters

N

WETLANDS WATER RESOURCES

Channel Network Evolution, 1998 (construction) to 2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

August 2004	Project No. 1044	**Figure 11**



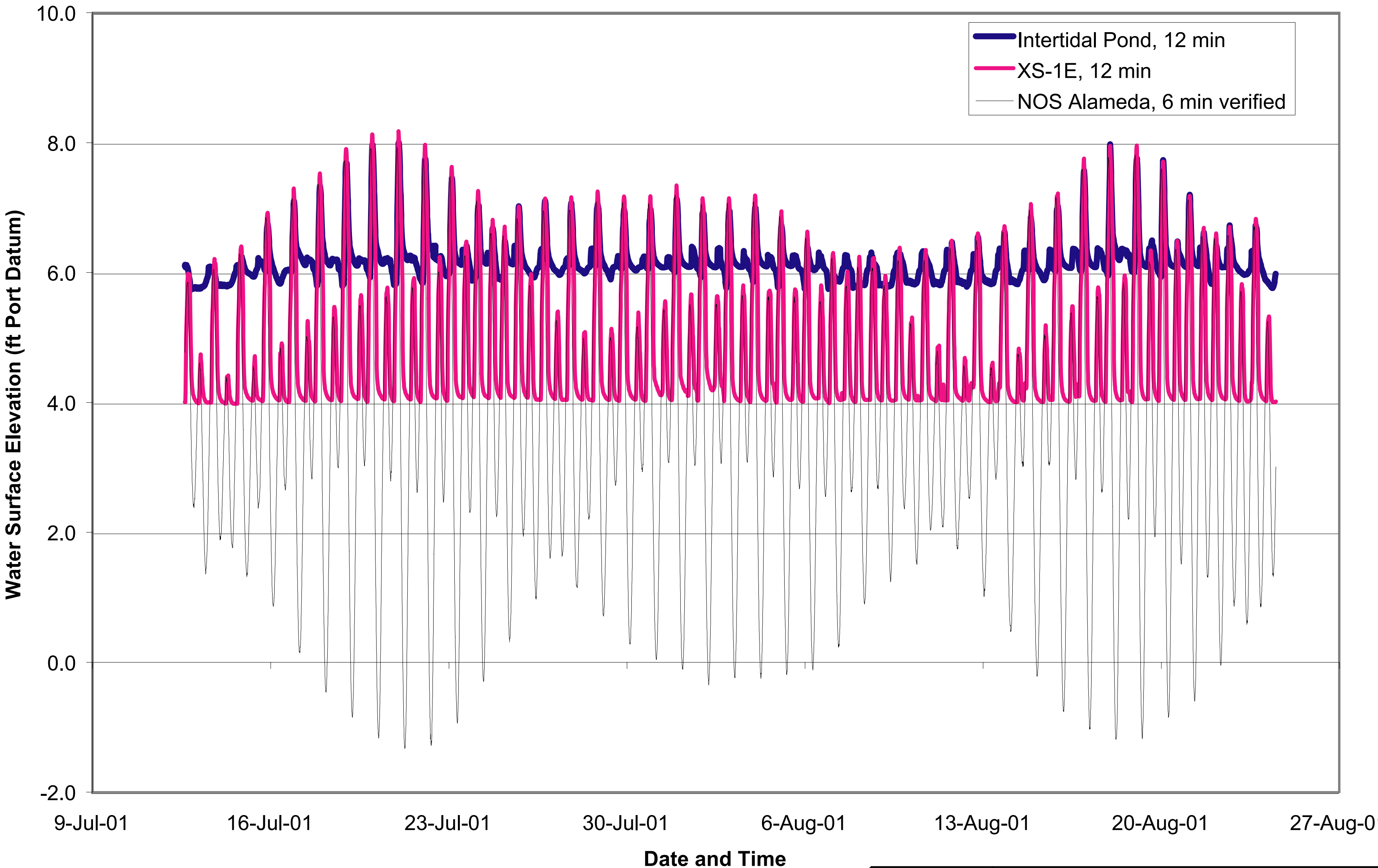
Period of Data Record: Jan 3 - Feb 1, 2001

WETLANDS AND WATER RESOURCES

WATER LEVELS
January 2001
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

September 2004	Project No.1044	Figure **12**

1044 Fig 12 WaterLevels-Jan2001 2004-0902



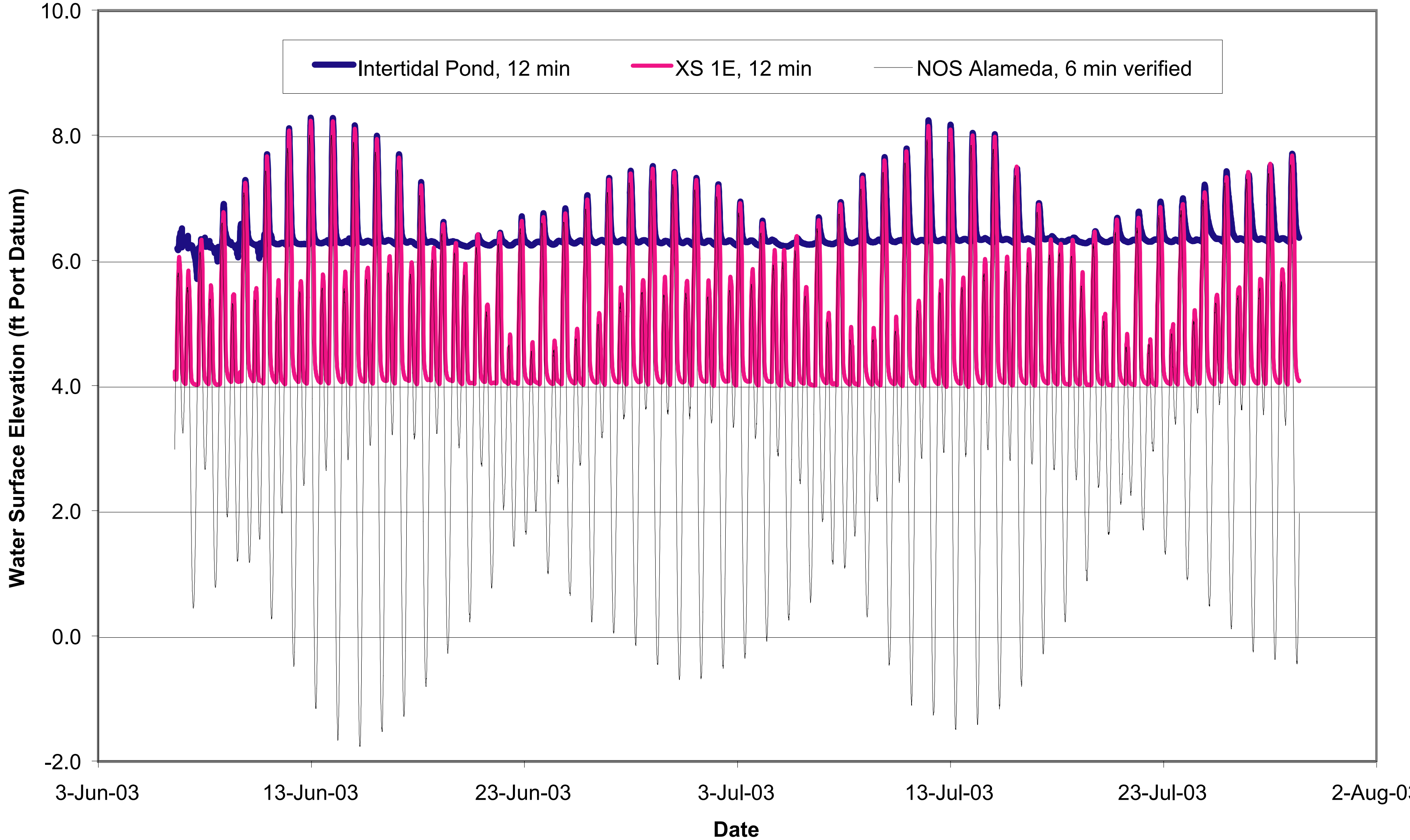
Period of Data Record: Jul 12 - Aug 24, 2001

WETLANDS AND WATER RESOURCES

WATER LEVELS
July-August 2001
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

August 2004	Project No.1044	Figure **13**

1044_Fig 13_WaterLevels-JulAug2001_2004-0816



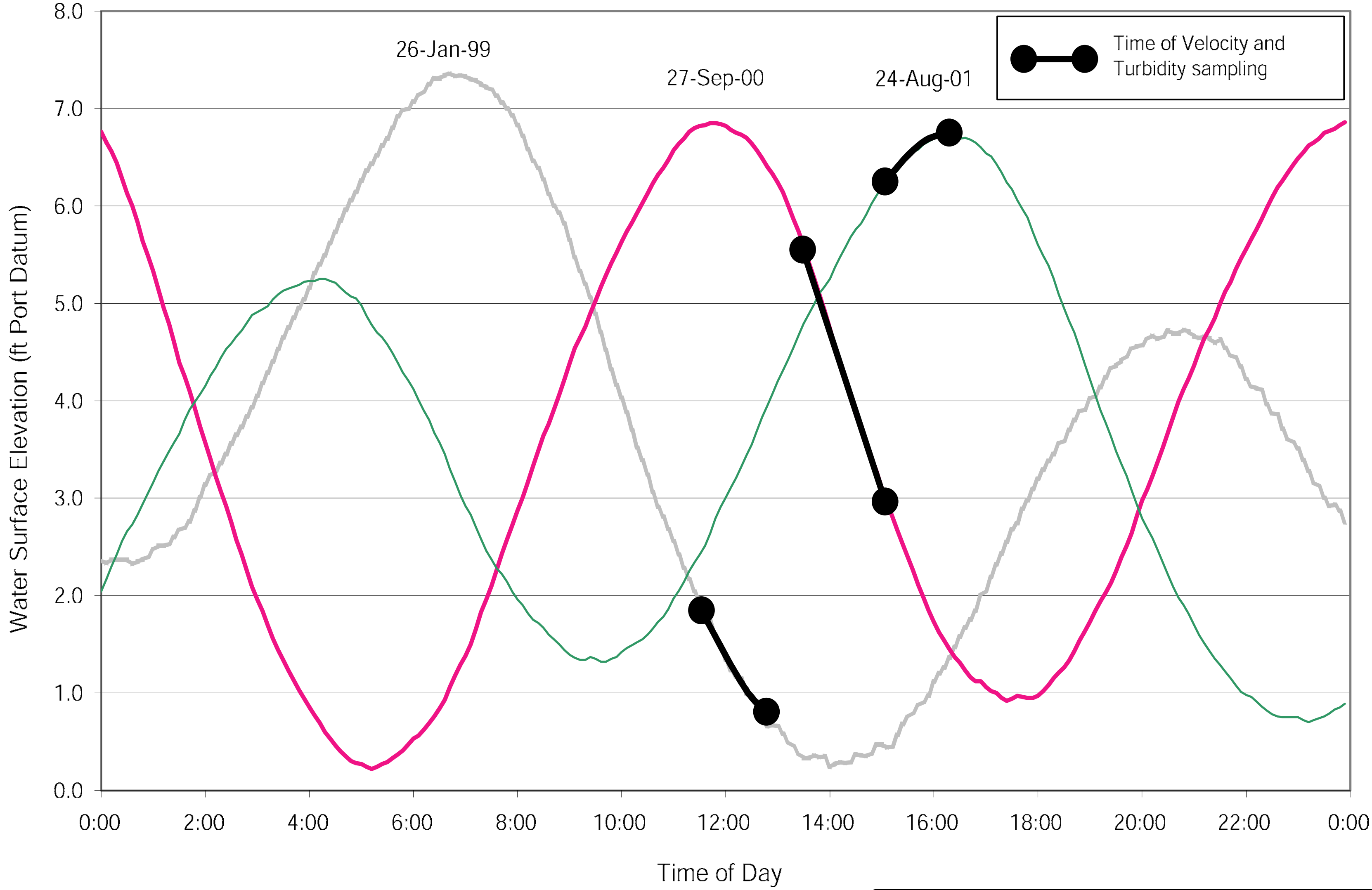
Period of Data Record: Jun 6 - Jul 29, 2003

WETLANDS AND WATER RESOURCES

WATER LEVELS
June-July 2003
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

August 2004	Project No.1044	Figure **14**

1044_Fig 14_WaterLevels-JunJul2003_2004-0816



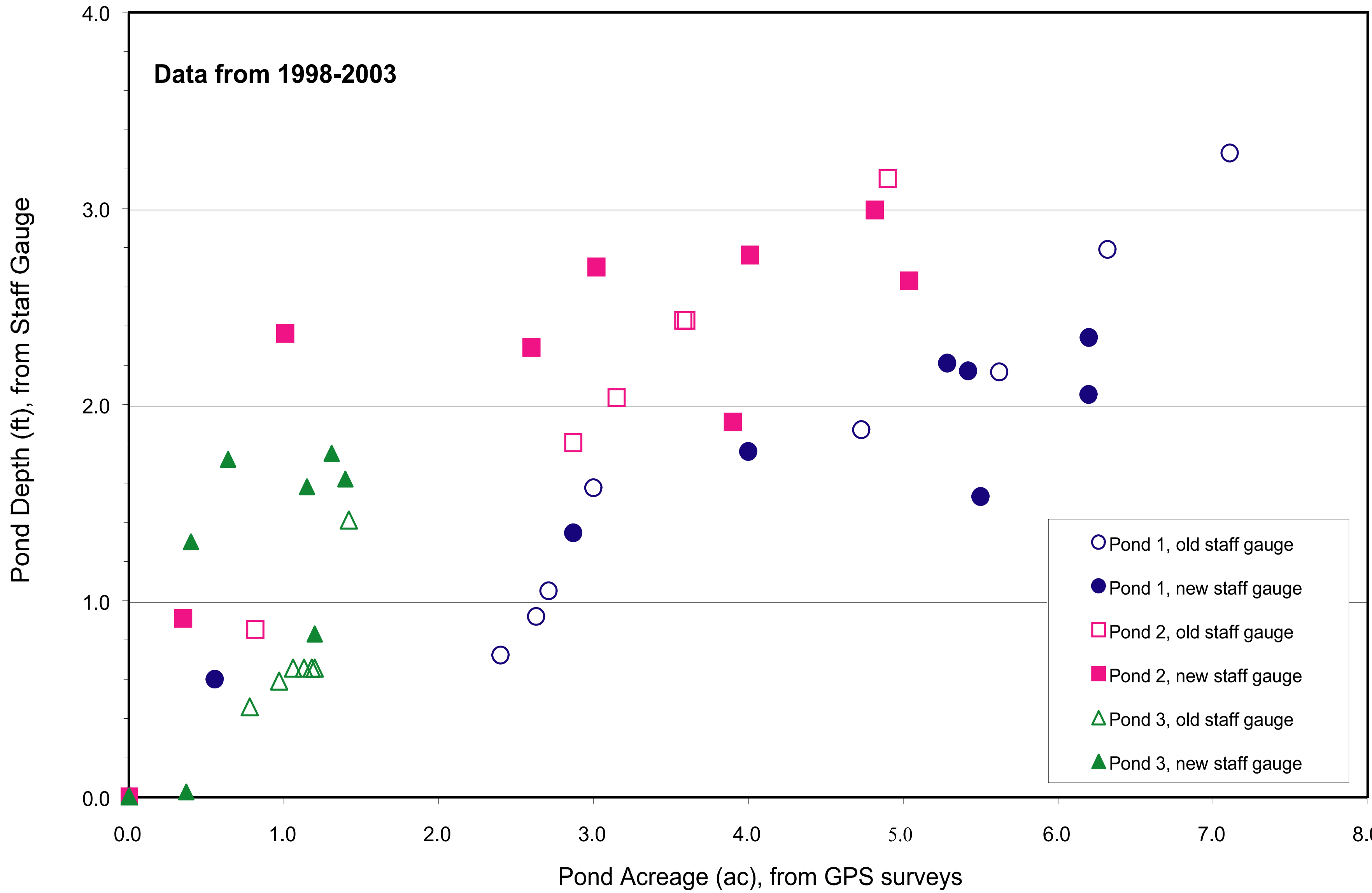
WETLANDS AND WATER RESOURCES

Tides During Velocity and Turbidity Sampling, 1999 - 2001

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

August 2004	Project No.1044	Figure **15**

1044_Fig 15_Velocity & Turbidity 99-01_2004-0827



WETLANDS AND WATER RESOURCES

STAGE-AREA CURVES
Seasonal Ponds

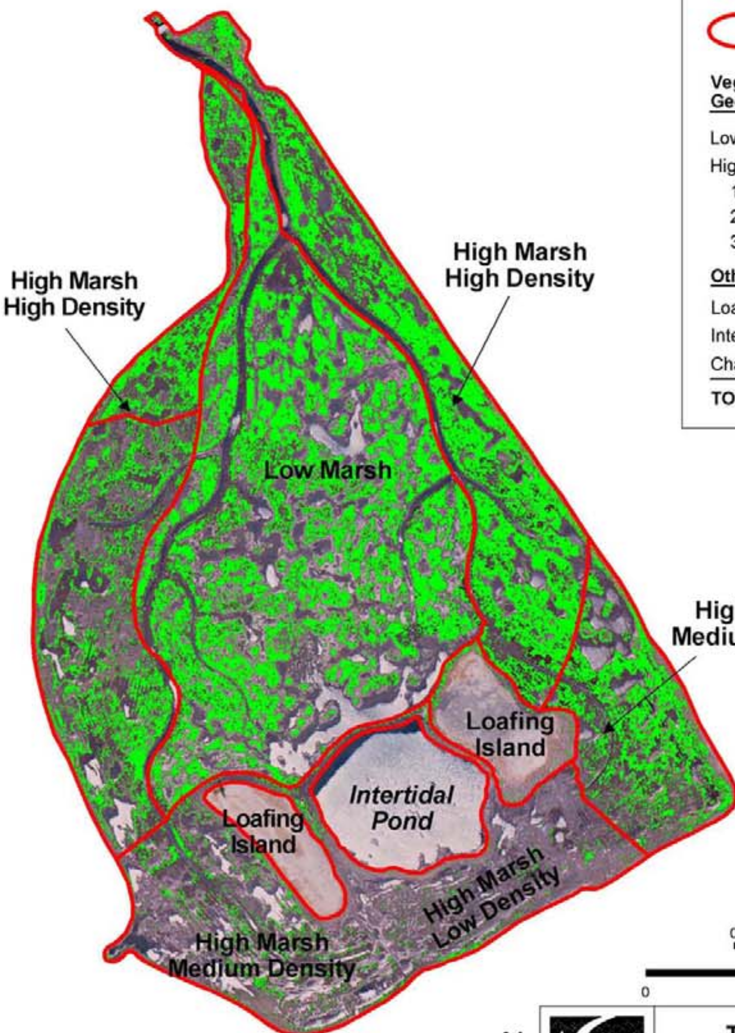
MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

August 2004	Project No.1044	Figure **16**

1044_Fig 16_StageAreaCurve_2004-0827

Photo Used in Data Digitization
Photo Date: 07/24/01

Data Overlay



Legend

Vegetation Cover 2001

Geomorphic Features

Vegetation Cover by Geomorphic Feature	Acres	% Cover
Low Marsh, Topographic	11.74	38.8% (4.56 ac.)
High Marsh, Topographic		
1) High % Cover	6.85	48.0% (3.29 ac.)
2) Med. % Cover	9.18	22.1% (2.02 ac.)
3) Low % Cover	3.07	5.5% (0.17 ac.)
Other Site Features		
Loafing Islands	1.94	
Intertidal Ponds	1.82	
Channel Network	1.16	
TOTAL SITE AREA	35.76	28.1% (10.04 ac.)

1:3000

0 125 250 500 Feet

(Scale applies to each frame individually)

0 125 250 Meters

N

WETLANDS WATER RESOURCES

Tidal Marsh Vegetation Map, 2001

Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

September 2004 | Project No. 1044 | **Figure 17**

Data Source: WWR, Air Flight Service (photo date 07/24/01)
Map File: Vegetation01_1044_11-22-02.mxd

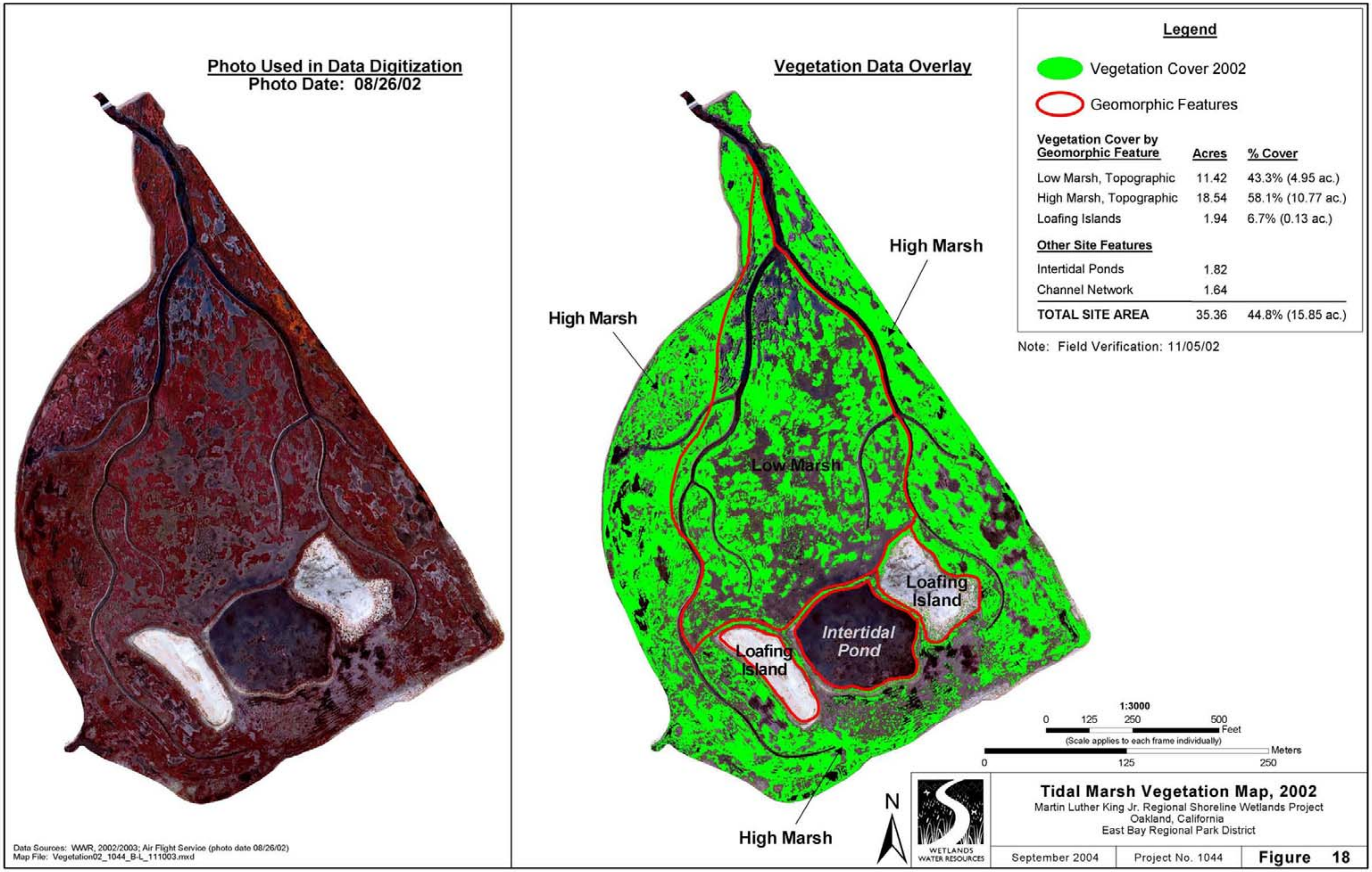
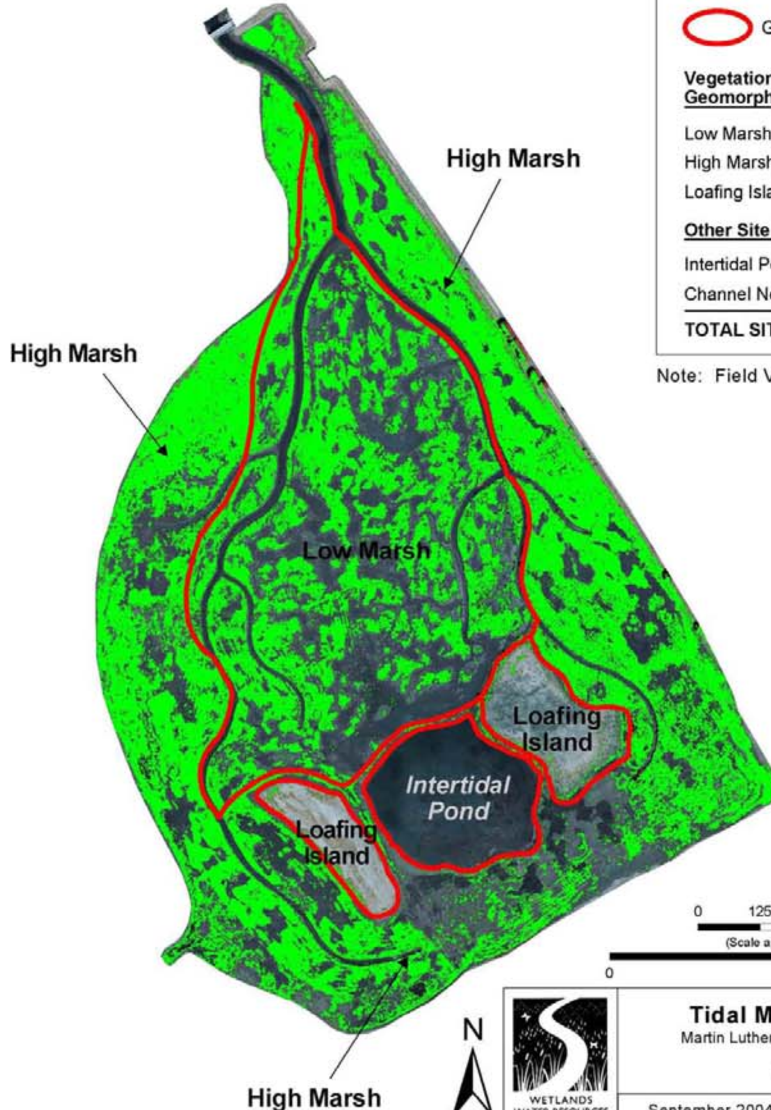


Photo Used in Data Digitization
Photo Date: 08/26/02
Vegetation Data Overlay
Legend
Vegetation Cover 2002
Geomorphic Features
Vegetation Cover by Geomorphic Feature | Acres | % Cover
Low Marsh, Topographic 11.42 43.3% (4.95 ac.)
High Marsh, Topographic 18.54 58.1% (10.77 ac.)
Loafing Islands 1.94 6.7% (0.13 ac.)
Other Site Features
Intertidal Ponds 1.82
Channel Network 1.64
TOTAL SITE AREA 35.36 44.8% (15.85 ac.)
Note: Field Verification: 11/05/02
High Marsh
High Marsh
Low Marsh
Loafing Island
Intertidal Pond
Loafing Island
High Marsh
1:3000
0 125 250 500 Feet
(Scale applies to each frame individually)
0 125 250 Meters
N
WETLANDS WATER RESOURCES
Tidal Marsh Vegetation Map, 2002
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District
September 2004
Project No. 1044
Figure 18
Data Sources: WWR, 2002/2003; Air Flight Service (photo date 08/26/02)
Map File: Vegetation02_1044_B-L_111003.mxd

Photo Used in Data Digitization
Photo Date: 08/29/03

Data Sources: WWR, 2003; HJW (photo date 08/29/03)
Map File: Vegetation03_1044_B-L_111003.mxd

Vegetation Data Overlay



Legend

Vegetation Cover 2003

Geomorphic Features

Vegetation Cover by Geomorphic Feature	Acres	% Cover
Low Marsh, Topographic	11.42	47.2% (5.40 ac.)
High Marsh, Topographic	18.54	58.4% (10.84 ac.)
Loafing Islands	1.94	6.7% (0.13 ac.)
Other Site Features		
Intertidal Ponds	1.82	
Channel Network	1.64	
TOTAL SITE AREA	35.36	46.30% (16.37 ac.)

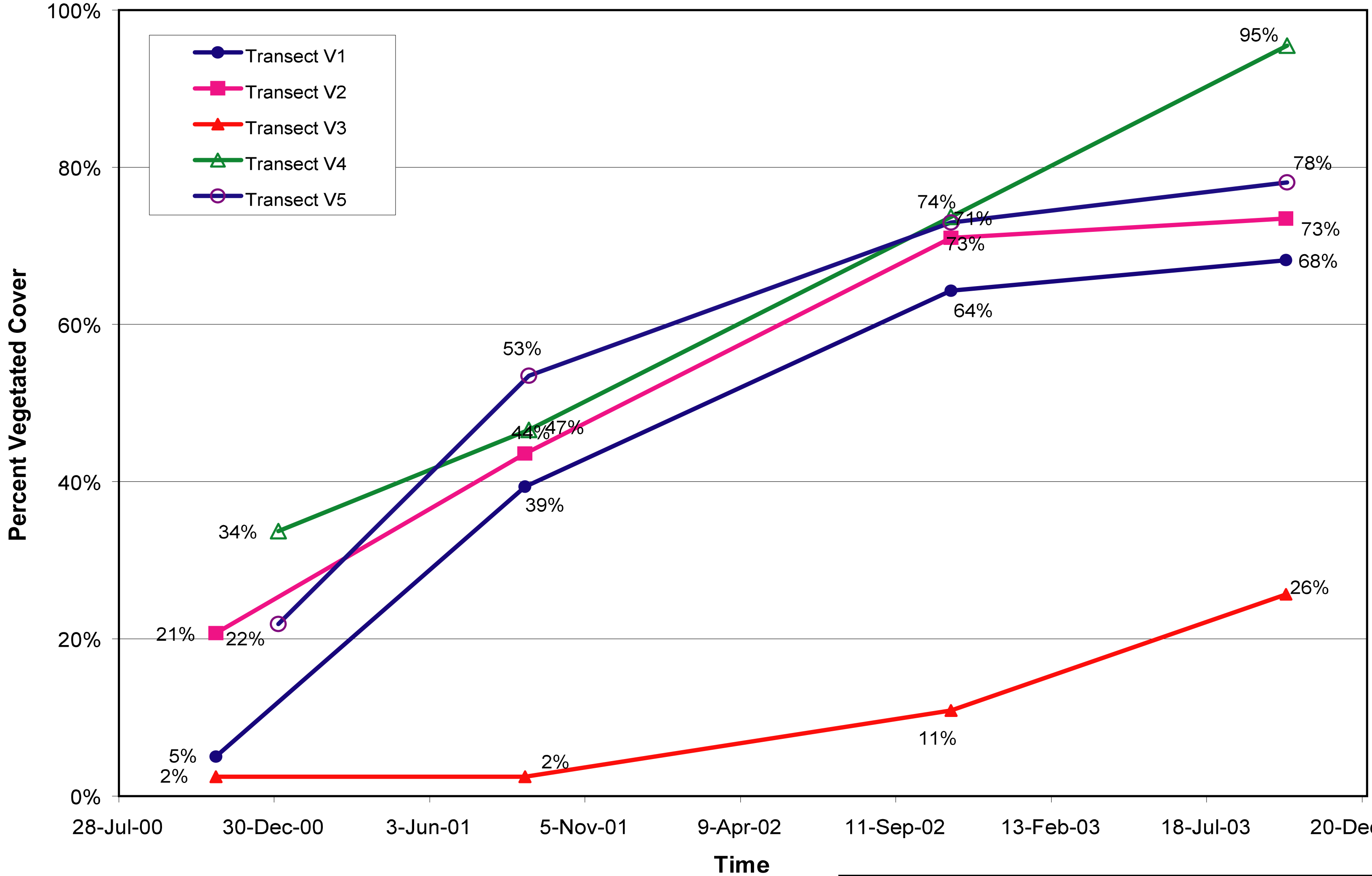
Note: Field Verification: 10/05/03

1:3000
0 125 250 500 Feet
(Scale applies to each frame individually)
0 125 250 Meters

WETLANDS WATER RESOURCES

Tidal Marsh Vegetation Map, 2003
Martin Luther King Jr. Regional Shoreline Wetlands Project
Oakland, California
East Bay Regional Park District

September 2004 | Project No. 1044 | **Figure 19**



WETLANDS AND WATER RESOURCES

TIDAL MARSH VEGETATION COVER VS. TIME

MLK Jr. Regional Shoreline Wetlands Project
East Bay Regional Park District

August 2004	Project No. 1044	Figure 20

1044_Fig 20_TidalVegvsTime_2004-0830

Appendices

Appendix A – Vegetation Species List

Appendix A – Vegetation Species List			
			Habitat
Family	**Species**	**Common Name**	**Type**
Apiaceae	*Foeniculum vulgare*	Sweet Fennel	S
Asteraceae	*Carduus pychnocephalus*	Italian Thistle	S
	Centaurea solstitialis	Yellow Star-thistle	S
	Conyza bonariensis	South American Horseweed	S
	Conyza canadensis	Horseweed	S
	Cotula coronopifolia	Brass-Buttons	T,S
	Gnaphaleum palustre	Lowland Cudweed	S
	Grindelia stricta* var. *angustifolia	Marsh Gumplant	T
	Hemizonia pungens ssp. maritima	Common Spikeweed	S
	Jaumea carnosa	Fleshy Jaumea	T
	Picris echioides	Bristly Ox-Tongue	S
	Sonchus spp.	Sow Thistle	S
	Taraxacum officinale	Common Dandelion	S
Boraginaceae	***Heliotropium curassavicum***	Seaside Heliotrope	S
Brassicaceae	*Hirschfeldia incana*	Black Mustard	S
	Brassica rapa	Field Mustard	S
Carophyllaceae	***Spergularia marina***	Sand Spurrey	T
Chenopodiaceae	***Atriplex patula***	Spear Oracle	T
	Atriplex triangularis	Spearscale	S
	Salicornia europaea	Annual Pickleweed	T
	Salicornia virginica	Pickleweed	T,S
	Salsola soda	Opposite leaf Russian Thistle	T,S
	Salsola tragus	Prickly Russian Thistle	S
Convolvulaceae	*Convovulus arvensis*	Bindweed	S

Appendix A – Vegetation Species List			
			Habitat
Family	**Species**	**Common Name**	**Type**
Cyperaceae	*Carex* spp.	Sedge	S
	Cyperus involucratus	African Cyperus	S
	Scirpus maritimus	Alkali Bulrush	S
	Scirpus robustus		S
Fabaceae	*Genista monspessulana*	French Broom	S
	Lotus corniculatus	Birdfoot Trefoil	S
	Lupinus spp.	Lupine	S
	Melilotus indica	Sour Clover	S
	Trifolium microcephalum	Small-head Clover	S
Frankeniaceae	***Frankenia salina***	Alkali Heath	T,S
Geraniaceae	*Geranium dissectum*		S
Juncaceae	***Juncus bufonious***	Toad Rush	S
Juncaginaceae	***Triglochin concinna***	Salt marsh arrow grass	T
Lythraceae	***Lythrum californicum***	California Loosestrife	S
	Lythrum hyssopifolium	Loosestrife	S
Malvaceae	*Malva neglecta*	Common Mallow	S
Onagraceae	*Epilobium ciliatum*	Common Willowherb	S
Plantaginaceae	*Plantago coronopus*	Cutleaf Plantain	S
	Plantago lanceolata	English Plantain	S
Polygonaceae	***Polygonum lapathifolium***	Willow Weed	S
	Rumex crispus	Curly Dock	S

Appendix A – Vegetation Species List			
Family	**Species**	**Common Name**	**Habitat Type**
Poaceae	*Avena fatua*	Wild Oat	S
	Bromus carinatus	California Brome	S
	Bromus hordeaceus	Brome	S
	Cortaderia jubata	Pampas Grass	S
	Crypsis vaginiflora	Prickle Grass	S
	Cynodon dactylon	Bermuda Grass	S
	Distichlis spicata	Saltgrass	T
	Hordeum brachyantherium	California Barley	S
	Hordeum jubatum	Foxtail Barley	S
	Hordum marinum ssp *gussoneanum*	Mediteranean Barley	S
	*Hordeum murinum*ssp. *Glaucum*		S
	Lolium perenne	Perennial Ryegrass	S
	Lolium multiflorum	Perennial Ryegrass	S
	***Nassella* spp.**	Needlegrass	S
	Polypogon monspeliensis	Annual Beard Grass	S
	Spartina alterniflora	Smooth Cordgrass	T
	Spartina foliosa	California Cordgrass	T
	Vulpia myuros	Rat-tail Fescue	S
Primulaceae	*Anagallis arvensis*	Scarlet Pimpernel	S
Scrophulariaceae	*Bellardia trixago*	Mediterranean Lineseed	S
Typhaceae	***Typha latifolia***	Broad-leaved Cattail	S

Notes:

Bold text indicates California native species

S = Seasonal Wetlands; T = Tidal Wetlands

Appendix B – Five-Year Avian Monitoring Analysis

Bird Use of Martin Luther King Jr. Regional Shoreline Wetlands Project

5-year Summary

Final Report
October 2004

Prepared by
Kriss Neuman

PO Box 2707
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Prepared for
East Bay Regional Park District
2950 Peralta Oaks Court
PO Box 5381
Oakland, CA 94506-0381

TABLE OF CONTENTS

1 Introduction

San Francisco Bay wetlands are of great importance to migratory shorebirds and waterfowl. More than one million shorebirds use bay wetlands each winter, leading to the designation of the bay as a Western Hemisphere Shorebird Reserve Network site of international importance (Goals Project 1999, Stenzel et al. 2002). San Francisco Bay is also an important area for waterfowl, with more than 50% of the diving ducks in the Pacific Flyway wintering in the shallow wetlands of the bay (Accurso 1992). More than 90% of historic wetlands in San Francisco Bay have been lost or altered, creating a need for wetland restoration.

In June 1998, the Port of Oakland completed construction for the restoration of wetlands on an approximately 71.5-acre (29.0-ha) site on San Leandro Bay, Alameda County, California. The restoration site includes 68 acres to mitigate for historic fill at the Oakland Airport's Air Cargo Site and the Port of Oakland's Distribution Center (the site of restoration), and 3.5 acres to mitigate for proposed fill on an adjacent site. The site is now managed by the East Bay Regional Park District as part of the Martin Luther King Jr. Regional Shoreline Park. The project was designed to include a mixture of wetland habitats, including tidal and seasonal wetlands. The site and restoration goals are described in detail in the project Monitoring and Maintenance Plan (LFR 1999). Key objectives of the restoration project included providing foraging and resting habitat for migratory shorebirds and waterfowl and suitable breeding habitat for California Clapper Rails (*Rallus longirostris obsoletus*).

To determine the effectiveness of the restoration, a five-year study of waterbird usage of the site was initiated in 1998. Since October 1998, trained volunteers from the Golden Gate Audubon Society have conducted systematic bird surveys at the site. Henkel and Neuman (2000), Henkel (2001), Henkel and Neuman (2002), Neuman (2002), and Neuman (2003) presented the results of the first five years of bird monitoring, through April 2003. This report summarizes the findings from five years of post-restoration monitoring, and assesses the effectiveness, thus far, of the restoration project.

2 Site Description and Methods

For the purpose of this study, the Restoration Site was divided into two areas: Tidal Wetlands and Seasonal Ponds (Fig. 1). The Tidal Wetlands, composing approximately 32.9 acres (13.3 ha), was subdivided into five areas: Marsh Plain, Intertidal Pond, Island A, Island B, and Channels. The largest of these areas, the Marsh Plain, is expected to develop over time into a mixture of low tidal marsh, dominated by cordgrass (*Spartina*), and high tidal marsh, dominated by pickleweed (*Salicornia* spp.). By year five of this study, approximately 75% of the Marsh Plain had been colonized by pickleweed with a few small patches of *Spartina*. The Seasonal Ponds consisted of three seasonal ponds (Pond 1, Pond 2, and Pond 3), surrounded by ruderal upland vegetation. The Seasonal Ponds remained dry until winter rains filled them. Pond 1 was the largest pond followed by Ponds 2 and 3, respectively (Table 1).

Table 1. Maximum Pond acreage of three ponds comprising the Seasonal Ponds, Martin Luther King Jr. Regional Shoreline, 1998-2003.

Monitoring Year	Pond 1	Pond 2	Pond 3	Total
1998-1999 (Mar)	7.1	6.4	1.4	14.9
1999-2000 (Feb)*	4.7	3.6	1.1	9.4
2000-2001 (Mar)	5.3	4.0	0.6	9.9
2001-2002 (Feb)	6.9	5.5	1.6	14.0
2002-2003 (Jan)	7.0	5.5	1.6	14.1

*Pond acreage only measured in February and July.

To provide an index of ongoing waterbird use of natural tidal saltmarsh nearby, two Reference Sites were monitored concurrently: the Eastern Reference Site and Western Reference Site (Fig. 1). Sub-areas in both Reference Sites included portions of Arrowhead Marsh (an intertidal saltmarsh), exposed mudflat, open water, rocky shoreline, and channels. The Western Reference Site contained a wooden pier, and the Eastern Reference Site contained a rocky peninsula, both of which were used for roosting by shorebirds. At low tide, significantly more mudflat was exposed at the Eastern than at the Western Reference Site. Motorized watercraft were allowed in the Western, but not the Eastern Reference Site. Because habitats at the Reference Sites differed somewhat from the Restoration Sites (most notably in the large expanse of open water in the Reference Sites), waterbird use at the Reference and Restoration Sites was not expected to be similar and comparisons made here between Reference and Restoration Sites should be interpreted through this lens.

Surveys were conducted from October 1998 through April 1999, and in the four subsequent years from August through April so that each "monitoring year" is composed of a fall-winter-spring cycle. Observers conducted one survey each month at each of four stages of the tidal cycle (high, low, incoming, and outgoing), at each of the four study areas, for a total of 688 scheduled surveys. Of these scheduled surveys, 636 surveys were conducted (Table 2, Appendix A). No surveys were conducted during summer months, when waterbird abundance is generally lowest.

Table 2. Number of surveys per year conducted at each of four study sites at, Martin Luther King Jr. Regional Shoreline, 1998-2003.

Monitoring Year	E. Reference	W. Reference	Tidal Wetlands	Seasonal Ponds
1998-1999	23	21	26	25
1999-2000	35	34	34	33
2000-2001	34	35	33	29
2001-2002	33	34	35	32
2002-2003	35	35	36	34

Observers recorded abundance and location of all waterbird and raptor species within the study area. Percent of shorebirds and waterfowl that were foraging was estimated during surveys at the Intertidal Pond (within the Tidal Wetlands) and Seasonal Ponds. Details of the survey protocol, and field data collection forms, are available in Henkel and Neuman (2000). The time required to survey a particular site varied from approximately 0.5 hr to 1.5 hr, depending on the number of birds present, visibility, size of the site, and other factors. Large flocks were carefully estimated, and care was taken to avoid double-counting flocks that moved within a site during the survey period. When calculating species richness (number of species recorded), we included unidentified species only if it was clear they did not overlap with identified species (e.g. Tern sp. contributed to species richness only if no other species of tern were recorded at that site). Community composition initially was assessed by comparing proportions of species-groups (shorebirds, waterfowl, gulls and terns, and other waterbirds). Shorebirds were further analyzed after subdividing species into four groups (Charadriidae: all plover species, Recurvirostridae: stilts and avocets, Small Scolopacidae: sandpipers of the genus *Calidris*, and Large Scolopacidae: all other shorebirds).

No statistical analyses were conducted for this report. Small sample sizes and high variability (because of the flocking nature of waterbirds) would limit the power of statistical tests in this report. In addition, habitat features of the Reference Sites varied somewhat from the habitat features planned for the Restoration Sites (e.g., deep open water in the Reference Sites). Thus, the Monitoring and Maintenance Plan (LFR 1999) stated that no quantitative comparisons should be made between the restoration and reference sites. However, for illustrative purposes, we did compare avian community composition among sites using the Percentage Similarity Index (PSI). This index is the sum of all the minimums of either 1) percentage of a given taxa (out of the total) in sample 1, or 2) the percentage of that taxa in sample 2 (Krebs 1998). Comparisons that result in greater PSI values (i.e., >70%) are more similar than comparisons that result in low values. Because many birds were identified only to general taxon (e.g., unidentified duck, or small shorebird), we conducted PSI analyses using five taxa: small shorebird (sandpipers of the genus *Calidris*), large shorebird (all other shorebirds regardless of size), waterfowl, gulls, and other waterbirds. These analyses potentially could be biased by missing survey data, so PSI analyses were limited to a subset of data that was complete: December through March, high and low tide only. Analyses for this study used corrected data from an updated Access database, and in some cases values may not be the same as in previous annual reports.

3 Results and Discussion

3.1 Abundance and Diversity

3.1.1 Species Richness

Species richness (number of species) at the Reference and Restoration Sites varied little among years, with Reference Sites generally supporting more species than Restoration Sites (Fig. 2, App. B). The average number of waterbird species observed per year was 36 (SD = 7, range 26-46) at the Seasonal Ponds and 45 (SD = 5, range 36-49) at the Tidal Wetlands compared to an average of 56 species (SD = 4, range 52-61) at the Eastern Reference Site and 53 species (SD = 2, range 50-56) at the Western Reference Site (Fig. 2).

At the Reference Sites, greater species richness probably was associated with greater habitat diversity, in particular the presence of open water and high tidal marsh that attracted several waterfowl and waterbird species seen only at the Reference Sites (e.g. Western Grebe, Surf Scoter, Virginia Rail; App. B). Interestingly, the Restoration Sites supported a similar number of shorebird species as the Reference Sites (App. B), indicating that the Restoration Sites, particularly the Tidal Wetlands, were highly suitable for shorebirds. Between the Restoration Sites, more species occurred at the Tidal Wetlands than at the Seasonal Ponds, probably as a result of the greater habitat diversity and tidal influence that attracted many more shorebird species at the Tidal Wetlands (App. B). The greatest annual change in species richness was at the Seasonal Ponds (Fig. 2).

Of 22 common shorebird species recorded in San Francisco Bay-wide surveys by Stenzel et al. (2002), all but three were recorded in this study. Snowy Plover (*Charadrius alexandrinus*), Spotted Sandpiper (*Actitus macularia*), and Red-necked Phalarope (*Phalaropus lobatus*) were not recorded. Snowy Plovers are found in San Francisco Bay almost exclusively south of Hayward, and Red-necked Phalaropes occur primarily in saline ponds during migration. Spotted Sandpipers are relatively uncommon migrants, and often occur in freshwater habitats. In this study, the general increase in number of species probably was related to improving habitat quality (e.g., greater prey diversity and abundance), but variability in species richness was a function of presence or absence of very rare species. Annual variability in species richness at all sites may have been related to small differences in observer effort.

3.1.2 Abundance and Community Composition

Mean abundance of the four major species groups (waterfowl, shorebirds, other waterbirds, gulls and terns) combined was greater at the Eastern Reference Site and the Tidal Wetlands than at the other two sites. Waterfowl dominated at the eastern Reference Site and shorebirds dominated at the other three sites. Most shorebirds at the Reference Sites were large Scolopacidae. In contrast, at the Restoration Sites most shorebirds were small Scolopacidae.

At the Eastern Reference Site, mean abundance of all waterbirds combined generally declined over the five monitoring years (Fig. 3). Species-group composition, however, was fairly consistent among years with waterfowl and to a lesser extent shorebirds accounting for most of the total. It is not known why abundance declined. At the Western Reference Site mean abundance of all waterbirds combined was variable over the five monitoring years but shorebirds consistently comprised the largest percentage of the total. The dominance of waterfowl at the Eastern Reference Site probably is linked to the large amounts of shallow open water. At the Western Reference Site, waterfowl may be limited by the potential occurrence of motorized watercraft (no data were collected on watercraft). The dominance of shorebirds at the Western Reference Site probably was associated with the presence of high tide roosting areas and, although waterfowl dominated at the Eastern Reference Site, shorebirds were almost as numerically abundant there as at the Western Reference Site. Among shorebird families, large Scolopacidae (predominantly Willet and Marbled Godwit; see appendix B for scientific names) dominated at both Reference Sites (Fig. 4). These large shorebirds consistently roosted at the Pier, in the Western Reference Site, and at other locations at the Reference Sites at high tide.

At the Seasonal Ponds mean abundance of all waterbirds peaked in the first and fifth years (Fig.3). Though mean abundance varied annually, species composition among four out of five years was consistent, with shorebirds, waterfowl and gulls and terns comprising similar proportions of annual abundance. During the anomalous year (1999-2000) mean abundance markedly declined and very few shorebirds were observed. Annual abundance of all taxa at the Seasonal Ponds was roughly proportional to total pond acreage (Table 1), which was a function of rainfall. The Tidal Wetlands supported considerably more birds than the Seasonal Ponds (Fig. 3, App. B). At the Tidal Wetlands, mean waterbird abundance was greatest in the second year (1999-2000) and shorebirds were the dominant species group in all years. In contrast to the Reference Sites, most shorebirds at both Restoration Sites were small Scolopacidae.

Overall, the Restoration Sites provided habitat for a great abundance of waterbirds. San Leandro Bay is a site of regional importance for shorebirds (Stenzel et al. 2002), and the Restoration Sites have substantially augmented the available habitat here. Mean shorebird abundance at the Tidal Wetlands was about 45 birds/ha, within the range of spring and fall densities for San Francisco Bay reported by Stenzel et al. (2002). This density is less than that reported for Elkhorn Slough, in the Monterey Bay area but greater than that reported for coastal wetlands in the vicinity of Point Reyes (Ramer et al. 1991).

3.2 Shorebird Occurrence Patterns

3.2.1 Shorebird Community Composition

Among shorebird families, small Scolopacidae dominated at both Restoration Sites in most years (Fig. 4). Secondary species groups, however, were different between the two sites, with Recurvirostridae dominating at the Seasonal Ponds, and large Scolopacidae at the Tidal Wetlands. Though Recurvirostridae were the second-most abundant shorebird family at the Seasonal Ponds, mean abundances of species in this family were actually greater at the Tidal Wetlands (App. B). Similarly, though Charadriidae comprised only a small proportion of shorebirds at the Tidal Wetlands, numerically they were far more abundant there than any other site. The diversity of foraging and roosting habitats, the tidal influence including retention of tidal waters, and the large size of the Tidal Wetlands are factors that probably contributed to the large numbers of shorebirds from all three shorebird families that used this site. The greatest difference in shorebird species composition among sites was the abundance of large Scolopacidae at the Reference Sites (where they roost at high tide), and the absence of these large shorebirds at the Seasonal Ponds. Apparently high-tide roosting habitat for large Scolopacids is poorer at the Seasonal Ponds, and these birds forage primarily on intertidal mudflats, a habitat not present at the Seasonal Ponds.

3.2.2 Shorebird Seasonal Patterns

At the Reference Sites shorebird abundance was lowest in early fall (August and September) and then increased somewhat in October and November to remain generally higher through April (Fig. 5). At the Seasonal Ponds shorebirds were not abundant until December and were present, though numbers varied, through April. At the Tidal Wetlands, shorebird abundance was generally greater during spring and fall than in winter (Fig.5). At the Seasonal Ponds, shorebird habitat does not become suitable until winter rains commence and the ponds fill up. This dynamic probably accounts for the seasonal pattern of habitat use. At the Tidal Wetlands, peaks in shorebird abundance coincided with spring and fall migration periods when from 300,000 to 900,000 shorebirds pass through San Francisco Bay (Stenzel et al. 2002). Many of these migratory shorebirds are small *Calidris* sandpipers which were the dominant shorebird group in the Tidal Wetlands. In contrast, bay-wide numbers of large Scolopacidae (Willet and Marbled Godwit combined) are relatively consistent from fall through spring (Stenzel et al. 2002), a pattern that was evident at the two Reference Sites dominated by these species.

3.2.3 Shorebird Tidal Patterns

Shorebirds were most abundant at the Western Reference Site and Seasonal Ponds at high tide, at the Tidal Wetlands at incoming tide and at the Eastern Reference Site at outgoing tide (Fig. 6). At the Western Reference Site, large Scolopacidae dominated at high tide when overall abundance was greatest, evidence that large shorebirds such as Willet and Marbled Godwit were using the roosting areas there. At the Eastern Reference Site, large Scolopacidae dominated at changing tides, the periods of greatest overall abundance there, indicating that large shorebirds probably were using the site for foraging.

At the Tidal Wetlands, abundance was generally high at changing tides and high tide, indicating that the Tidal Wetlands were important for foraging and for high tide roosting. Small Scolopacidae dominated at all tides at the Tidal Wetlands except low tide, when total shorebird abundance was extremely low. During low tide, small Scolopacidae and other shorebirds primarily forage on large exposed mudflats in San Francisco Bay, outside the study area (Stenzel et al. 2002). At the Seasonal Ponds, small Scolopacidae dominated during high tide, the period of greatest overall abundance, evidence that the ponds provide suitable high tide roosting and foraging areas for small shorebirds.

3.2.4 Shorebird Use of Restored Habitat Sub-areas

Further analysis of shorebird occurrence at sub-areas within the Restoration Sites reveals differences in shorebird use of different habitats. Most shorebirds at the Tidal Wetlands occurred on the Marsh Plain (Fig. 7). This pattern was consistent among all tides and monitoring years. The Marsh Plain is the largest sub-area of the Tidal Wetlands, and provides the most foraging habitat. The only other sub-area to receive consistent use among all tides and monitoring years was the Intertidal Pond. Use of the Intertidal Pond generally was greatest at incoming tides, but the pond was also used at high and outgoing tides (Fig. 7). The Intertidal Pond retains shallow water throughout the tidal cycle, and may provide foraging habitat when mudflat habitat becomes unavailable elsewhere. Within the Tidal Wetlands, the two most important features for shorebirds were the Marsh Plain and the Intertidal Pond. However, the Marsh Plain is significantly larger than any other habitat feature and the difference in relative size between this and other sub-areas may account for the differences in shorebird abundance.

The two loafing islands (Islands A and B) were used almost exclusively at high tide and overall Island A was used more than Island B. The occurrence of shorebirds on the loafing Islands at high tide indicates that the islands provided a valuable high tide roost location. Shorebird use of the Channels was inconsistent among years and tidal stages. Shorebird use of the Seasonal Ponds was related to overall pond acreage; abundance generally was greater at larger ponds (i.e. Pond 1 followed by Ponds 2 and 3; Fig. 8).

Table 3 summarizes the relative use of the restored habitat sub-areas by shorebirds. Within the Tidal Wetlands the areas that received the most use (as indicated by mean abundance) were the Marsh Plain and the Intertidal Pond. These two areas supported significant numbers of shorebirds at all tidal stages except low tide. The loafing islands (Islands A and B) and the Seasonal Ponds were most important as high tide roost areas. The Channels received some use by shorebirds, but were probably most important for inundation of other sub-areas.

Table 3. Relative shorebird use of habitat sub-areas at restored wetlands at Martin Luther King Jr. Regional shoreline, 1998-2003.

Tidal Stage	Intertidal Pond	Marsh Plain	Channels	Islands	Seasonal Ponds
Incoming	high	high	low	low	low
High	moderate	moderate	low	moderate	moderate
Outgoing	moderate	high	low	low	low
Low	low	low	low	low	low

3.2.5 Shorebird Behavior

One of the primary goals of the restoration was to provide high-tide roosting locations for shorebirds (LFR 1999). Within the Restoration Sites, important high-tide roosting sites include the Marsh Plain, Intertidal Pond, and Islands A and B (all within the Tidal Wetlands), and Pond 1 (in the Seasonal Ponds). In addition to censusing these areas for total abundance, observers also determined behavior (foraging or roosting) for shorebirds at the Seasonal Ponds and at the Intertidal Pond within the Tidal Wetlands. At the Seasonal Ponds, 78% of birds were assigned a behavior (total n = 13,951). At the Intertidal Pond, 72% of shorebirds were assigned a behavior (total n = 18,365).

At high tide at the Seasonal Ponds a smaller proportion of shorebirds (42%) were roosting than at the Intertidal Pond (95%), but the Seasonal Ponds supported a numerically greater number of both roosting and foraging shorebirds (Fig. 9). In addition, shorebird abundance at the Seasonal Ponds was markedly greater at high tide than at the other three tides, indicating that shorebirds were attracted to this area when tidal areas were inundated. Although intertidal mudflat consistently provides the most important foraging habitat for shorebirds in the San Francisco Bay area (Page et al. 1979, Stenzel et al. 2002), when this habitat is not available at high tide, non-tidal habitats provide important roosting and foraging opportunities for shorebirds (Warnock et al. 2002).

At the Intertidal Pond abundance was greatest at incoming tide, when most shorebirds were foraging (Fig. 9). Roosting behavior was more frequent at high and outgoing tides, but fewer shorebirds were present here during those tides. It is not known why incoming tides provided the best habitat for shorebirds, but presumably the influx of shorebirds during incoming tides was related to the inundation of intertidal mudflat outside the study area. Burger et al. (1977) found that shorebirds on sandy beaches and intertidal mudflats foraged mostly during incoming tides, and prey availability in the Intertidal Pond may have been greatest during incoming tides. Because of delayed and muted tidal action, lowest water levels occurred in the Intertidal Pond well after low tide, during incoming tides.

In the San Francisco Bay area, delayed tidal action (e.g., due to dikes), and adjacent non-tidal habitats (e.g., salt ponds) provide a mosaic of habitats available to waterbirds at various tidal stages (Holway 1990, Stenzel et al. 2002, Warnock et al. 2002). Although shorebirds in the San Francisco Bay area may move more than 20 km between foraging and roosting areas (Shuford et al. 1989), the proximity of alternate high-tide habitat can lead to increased numbers of shorebirds using tidal mudflats at a given location (Masero et al. 2001). In the San Francisco Bay area, diked wetlands and salt ponds provide high-tide habitat for many species of shorebirds, and some shorebirds forage at these alternate habitats at both high and low tides (Warnock et al. 2002). The Restoration Sites in this study similarly provided alternate habitat during high and incoming tides, and may help to enhance shorebird populations on a regional scale.

3.3 Waterfowl Occurrence Patterns

3.3.1 Waterfowl Seasonal and Tidal Patterns

More than 50% of the diving ducks in the Pacific Flyway winter in the shallow wetlands of San Francisco Bay and large numbers occur from October through April (Accurso 1992). In this study, waterfowl were most abundant at all four monitoring sites during fall and winter. Although many ducks were not identified to species, the most abundant taxon identified was scaup species (Appendix B), which are diving ducks. American Wigeon, a dabbling duck, was the second most abundant taxon (Appendix B). The Eastern Reference Site supported the greatest abundance of waterfowl and was utilized at all four tidal stages (Fig. 10). At the Western Reference Site, peak numbers occurred at high tide and generally numbers were lowest at low tides. At the Seasonal Ponds, numbers were similar at all four tides, probably due to the lack of tidal influence on water level. In contrast, numbers were high at the Tidal Wetlands at high and outgoing tides and very low at low and incoming tides, probably because water levels during low and incoming tides were insufficient. In contrast to the Reference Sites, the Restoration Sites were used primarily by dabbling ducks. As with shorebirds, abundance of waterfowl at the Seasonal Ponds was roughly proportional to pond size. Pond size and water depth are important factors in determining habitat quality for waterfowl (Colwell and Taft 2000).

3.3.2 Waterfowl Behavior

At the Seasonal Ponds, 87% of 12,722 waterfowl were assigned a behavior. Of these birds, about half were foraging, and tidal stage had little influence on behavior (Fig. 11). Because the Seasonal Ponds were not influenced by tide, waterfowl foraged and roosted there at all tides, although abundance was greatest at incoming tide.

3.4 California Clapper Rails

The California Clapper Rail was federally listed as endangered in 1970. Population decline was caused primarily by loss of salt marsh habitat in San Francisco Bay (USFWS 1984). Clapper Rails require high salt marsh habitat, with well-developed cordgrass or pickleweed vegetation and tidal channels (USFWS 1984, Garcia 1995, Foin et al. 1997).

Clapper Rails were seen or heard on surveys only in the Eastern and Western Reference areas. Rails were reported in Arrowhead Marsh, on exposed mudflat, on rocky shoreline, and in open water. The greatest number of individuals recorded during one survey was 10 at the Eastern Reference Site during a high tide in December 2002.

Mean and maximum number of rails at each reference site varied slightly over the five monitoring years, but abundance was consistently greater at the Eastern Reference Site (Fig. 12). During a boat-based survey of Arrowhead Marsh on 3 December 2003 at high tide, 60 Clapper Rails were detected (J. Didonato, pers. comm.). The large discrepancy between the maximum number of rails detected from shore and the number detected from the boat indicate that shore-based surveys may provide only a relative index of Clapper Rail use of the Reference Sites.

3.5 Burrowing Owls

Burrowing Owl (*Athene cunicularia hypugea*) populations in California have declined as a result of loss of grassland nesting habitat and are listed by the State of California as a Species of Special Concern. The Maintenance and Monitoring Plan (LFR 1999) specifies that Burrowing Owl use of the Restoration Site must be documented. Although it was not a primary goal of the project to provide habitat for Burrowing Owls, four artificial nest boxes were installed at the site, west of the Seasonal Ponds (Fig. 1). Nest boxes have been used successfully at other sites (Trulio 1995). Burrowing Owls were recorded in all years of the study except 1998-1999, with the greatest number of sightings recorded in 2001-2002. All owl sightings except one sighting at the Tidal Wetlands were recorded at Pond 1 in the vicinity of artificial nest burrows that were installed as part of the project implementation. Breeding by Burrowing Owls was documented only in spring/summer 2001. Destruction and occupation of the constructed burrowing owl nest chambers by burrowing rodents (California ground squirrels *Spermophilus beecheyi*) and excessive vegetative growth may have inhibited the rate of burrow occupancy by nesting owls.

3.6 Community Analysis

Percentage Similarity Index (PSI) values between sequential years at a given site were greater overall at high tide than at low tide (Fig. 13), indicating that avian communities within the study area were more predictable at high tide, when abundance was greater. At low tide, PSI values (a measure of community similarity) between years were consistently high in the Eastern Reference area and the Seasonal Ponds, but were lower at the Western Reference Site and the Tidal Wetlands. At high tide, PSI values were greatest at both Reference Sites, and were variable at the Restoration Sites. At high tide, when birds were more abundant at the Restoration Sites, we expected PSI values to be lower than at the Reference Sites. At the Restoration Sites, habitat quality for different species changed on an annual basis, in contrast to the relatively static Reference Sites. As the Restoration Sites continue to evolve, we predict that inter-annual PSI values will continue to fluctuate and then eventually rise and level off, indicating a more stable avian community as habitat change slows.

Between the two Reference Sites, annual PSI values ranged from 0.26 to 0.76 (mean = 0.53, SD = 0.18). Mean inter-annual PSI values within the combined Reference Sites (Fig. 14, straight lines) provide an index of natural variability with which to compare variability in PSI values between Reference and Restoration Sites (Fig. 14, variable lines). At low tide, PSI values between Restoration Sites and Reference Sites were greater than the mean inter-annual value within the Reference Sites in all years except 1998-1999. Thus, avian communities at low tide were more similar between Restoration and Reference Sites in most years than they were between sequential years within the Reference Sites. At high tide, PSI values between Restoration and Reference Sites again increased after the 1998-1999, but exceeded the mean reference site value only in 2000-2001 and 2002-2003. The mean Reference Site values do not provide absolute goal values for PSI values between the Reference and Restoration Sites, but observed PSI values indicate that avian communities in the Restoration Sites have evolved over the five years of this study, and are now quite similar to the avian communities at the Reference Sites. Many differences still occur, as described earlier in this report (e.g., more small shorebirds at the Tidal Wetlands, and more diving ducks at the Reference Sites), but overall, the Restoration Sites now provide habitat for a similar avian community to that found in the Reference Sites.

4 Summary

Over the five years of this study, the Restoration Sites provided valuable foraging and roosting habitats for many species of waterbirds, particularly at changing and high tides. Within the Restoration Sites, species diversity has increased slightly, and abundance at the Seasonal Ponds also has increased, possibly due to generally greater pond depths that provide a greater linear area for foraging or safe loafing. Habitat within the Tidal Wetlands has become more vegetated over time, but the site continues to support the majority of shorebirds. At the Seasonal Ponds, an increase in abundance and species diversity may reflect inter-annual variation in use of the site related to local factors (e.g. annual differences in water depth) or large-scale factors (e.g. fluctuations in shorebird populations). The Western Reference Site and the Seasonal Ponds appeared to be important in providing high-tide roosting habitat for shorebirds, but most shorebirds apparently move out of the study area to forage at low tide.

Clapper Rails only were seen in the Reference Sites. Additional years of marsh development will probably be necessary before vegetation in the Tidal Wetlands provides enough cover for rails, and detection of rails in the restoration site may be limited by weather and inaccessibility. Burrowing Owls were observed on the Restoration Site regularly after the first year, but were documented nesting at the site only in spring/summer 2001.

Summary Points

- Restoration Sites provided important habitat for a variety of shorebird, waterfowl, and other waterbird species.
- Seasonal abundance of shorebirds at the four monitoring sites varied with species composition: at the Tidal Wetlands, sandpipers were dominant, and abundance peaked during migration periods; at all other sites, larger shorebirds were dominant, and abundance peaked during winter and spring.
- Seasonal abundance of waterfowl peaked at all sites during winter.
- Restoration and Reference Sites supported different waterfowl communities: dominant waterfowl at Restoration Sites were diving ducks (e.g., Scaup); dominant waterfowl at Reference Sites were dabbling ducks (e.g., American Wigeon).

- The Tidal Wetlands supported more shorebirds than any other site, particularly small sandpipers of the genus *Calidris*.
- Habitat quality for shorebirds and waterfowl at the Seasonal Ponds was a function of rainfall, which affected pond size and depth.
- Shorebird abundance was lowest at all sites at low tide, indicating that shorebirds moved out of the study area at low tide to forage elsewhere in the region.
- All sites provided high-tide roosting habitat for shorebirds. Within the Restoration Sites, the Islands and Intertidal Pond (with the Tidal Wetlands), and the Seasonal Ponds provided important high-tide roosting habitat.
- Waterfowl used the Seasonal Ponds at all tidal stages and the Tidal Wetlands primarily during high and outgoing tides.
- Clapper Rails were recorded in Arrowhead Marsh in all monitoring years, but were not yet seen in the Restoration Sites.
- Burrowing Owls were recorded in all monitoring years except 1998-1999, but were confirmed breeding only during spring/summer 2001.
- Comparison of avian communities using PSI analysis showed that the Restoration Sites now support communities that are roughly similar to the Reference Sites.

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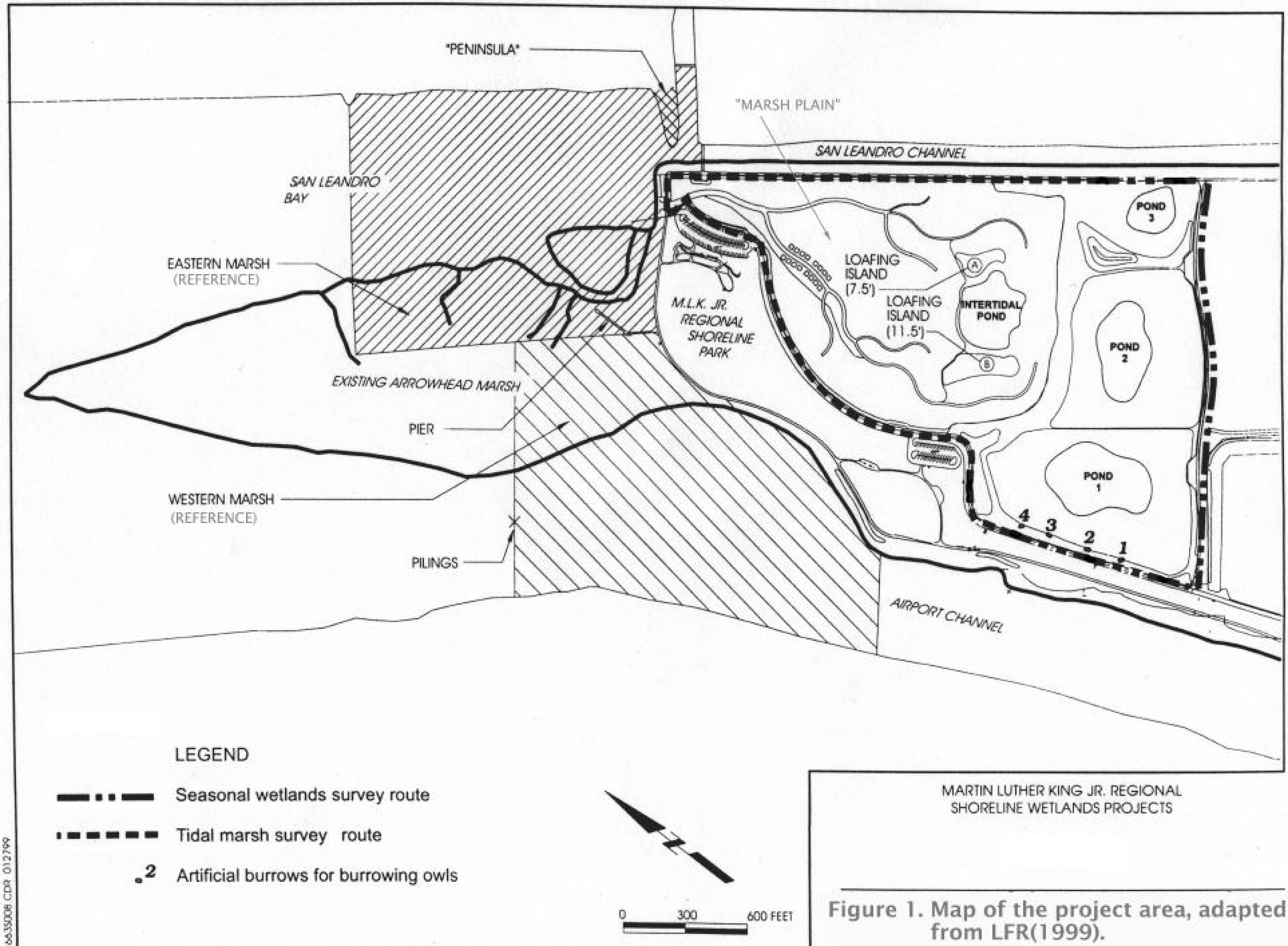

Figure 1. Map of the project area, adapted from LFR(1999).

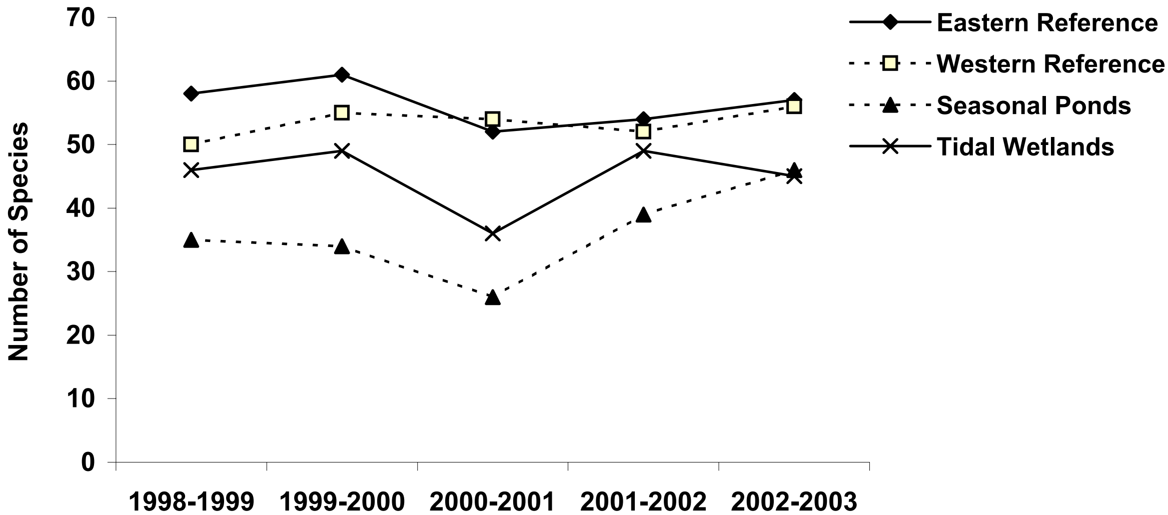

Figure 2. Total species richness at the four monitoring sites, 1998-2003.

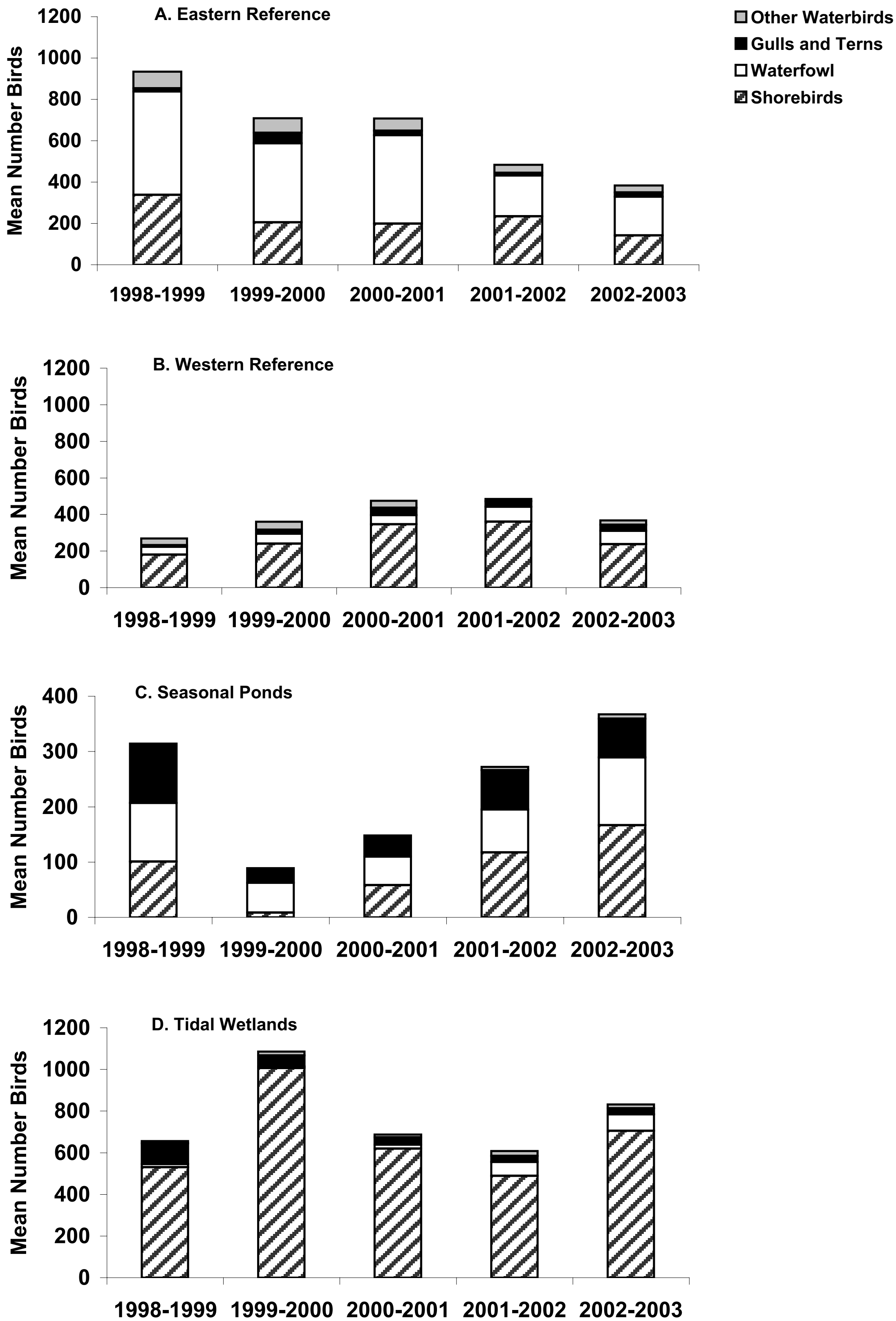

Figure 3. Mean abundance of the four major species groups at the four monitoring sites, 1998-2003. Note large differences in Seasonal Ponds y-axis.

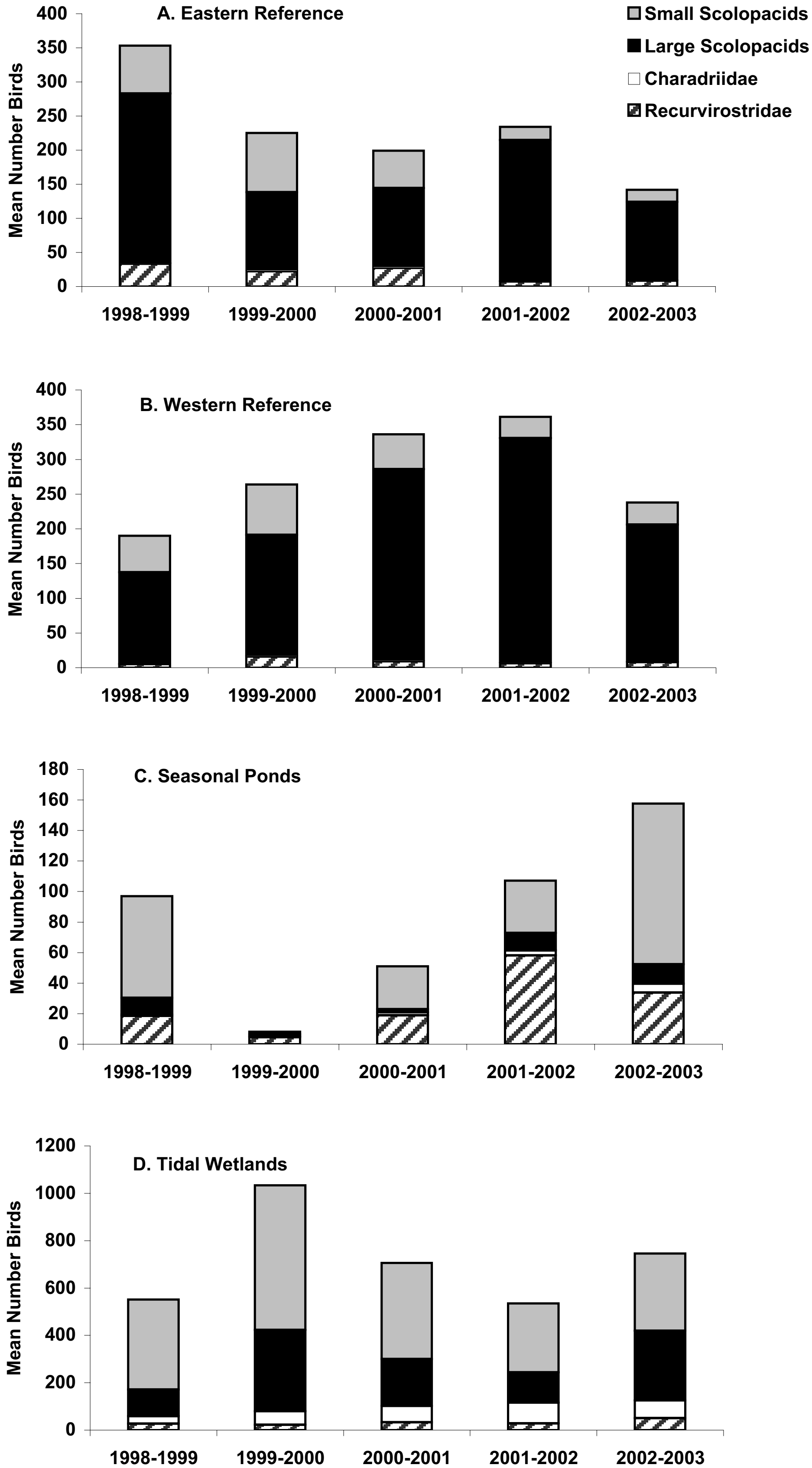

Figure 4. Mean abundance of four types of shorebirds at the four monitoring sites, 1998-2003. Note large differences in y-axes.

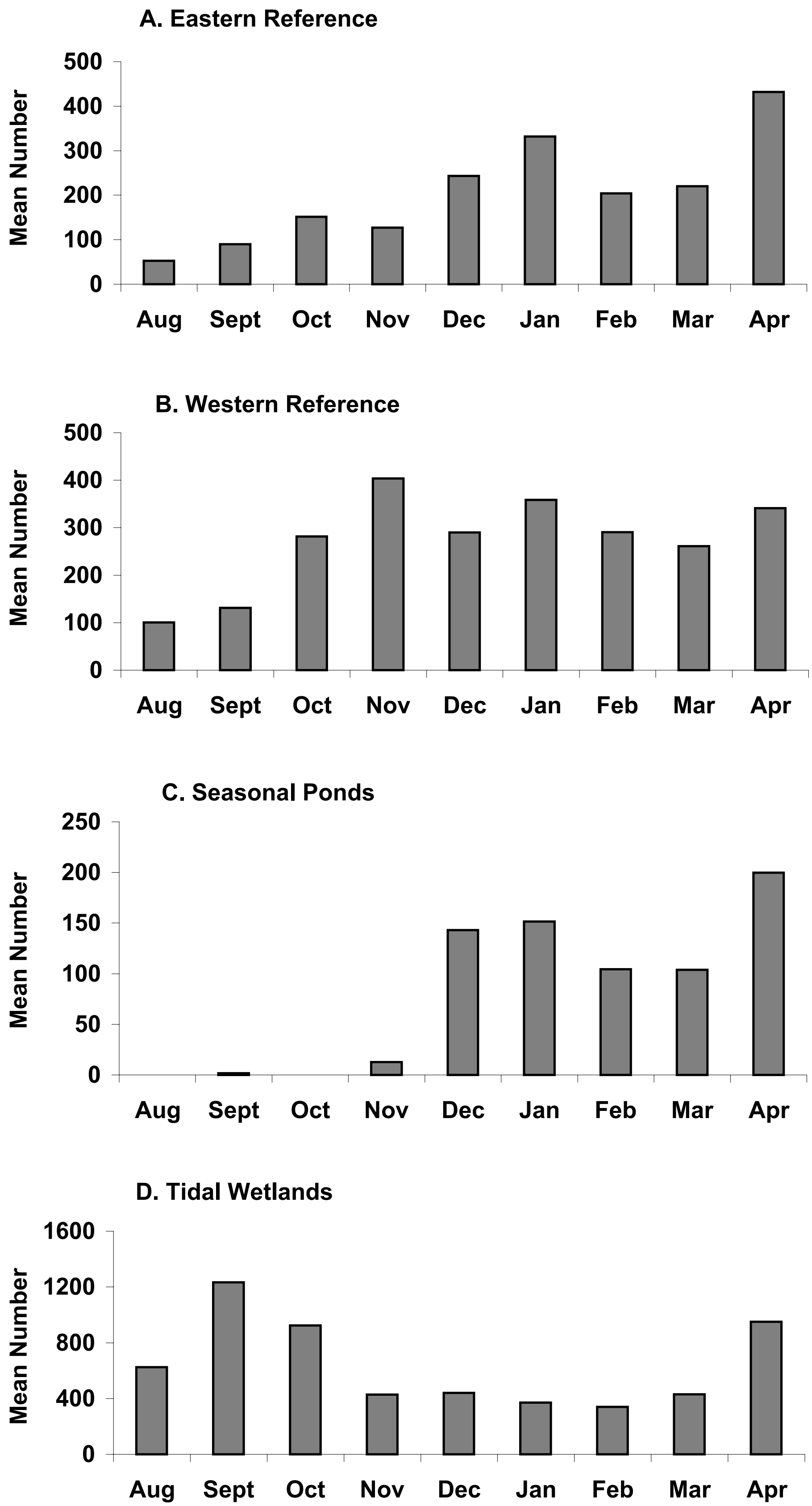

Figure 5. Mean seasonal abundance of shorebirds at the four monitoring sites, 1998-2003. Note large difference in y-axes.

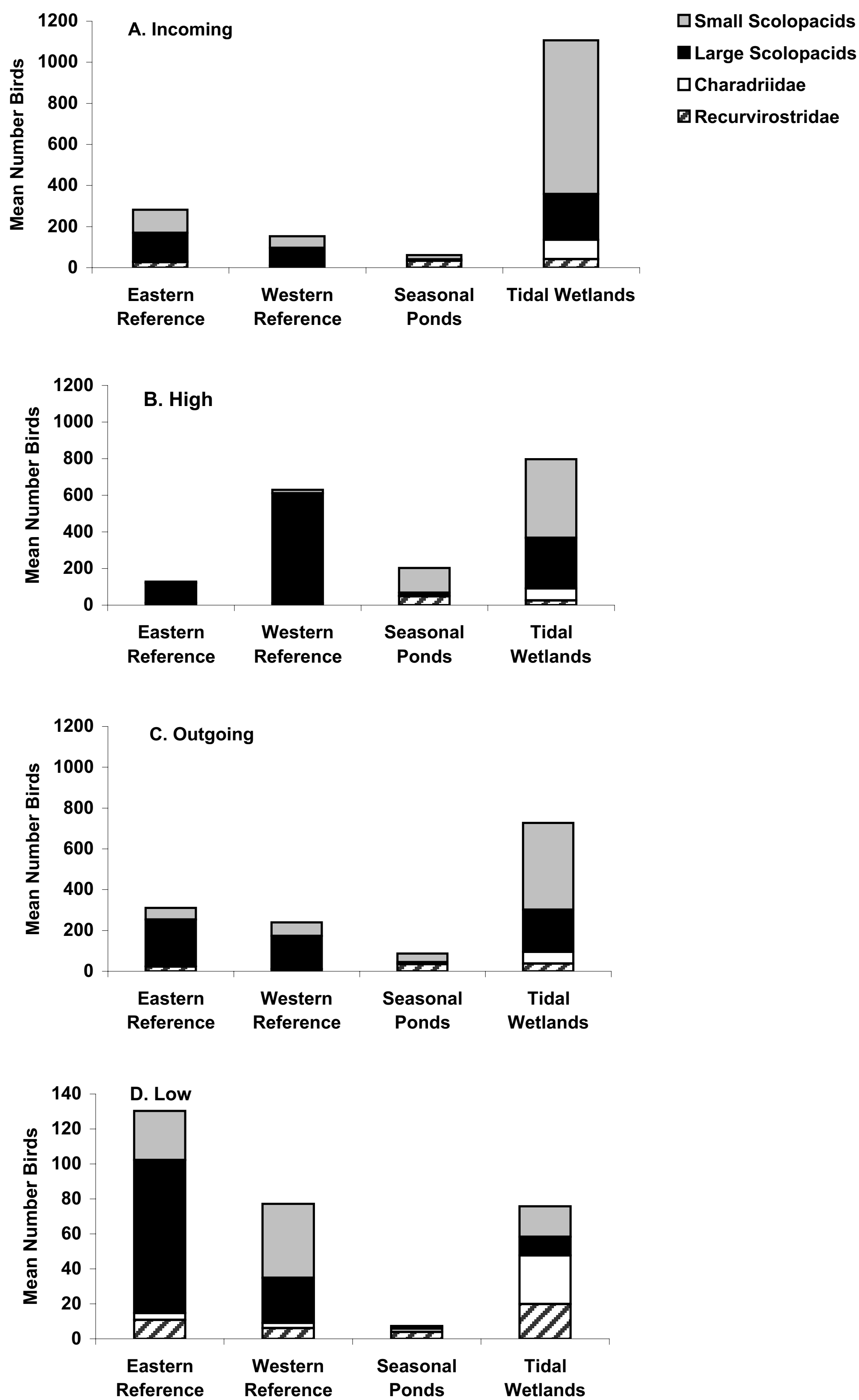

Figure 6. Mean abundance of four types of shorebirds at four monitoring sites by tidal stage, 1998-2003. Note large differences in Low Tide y-axis.

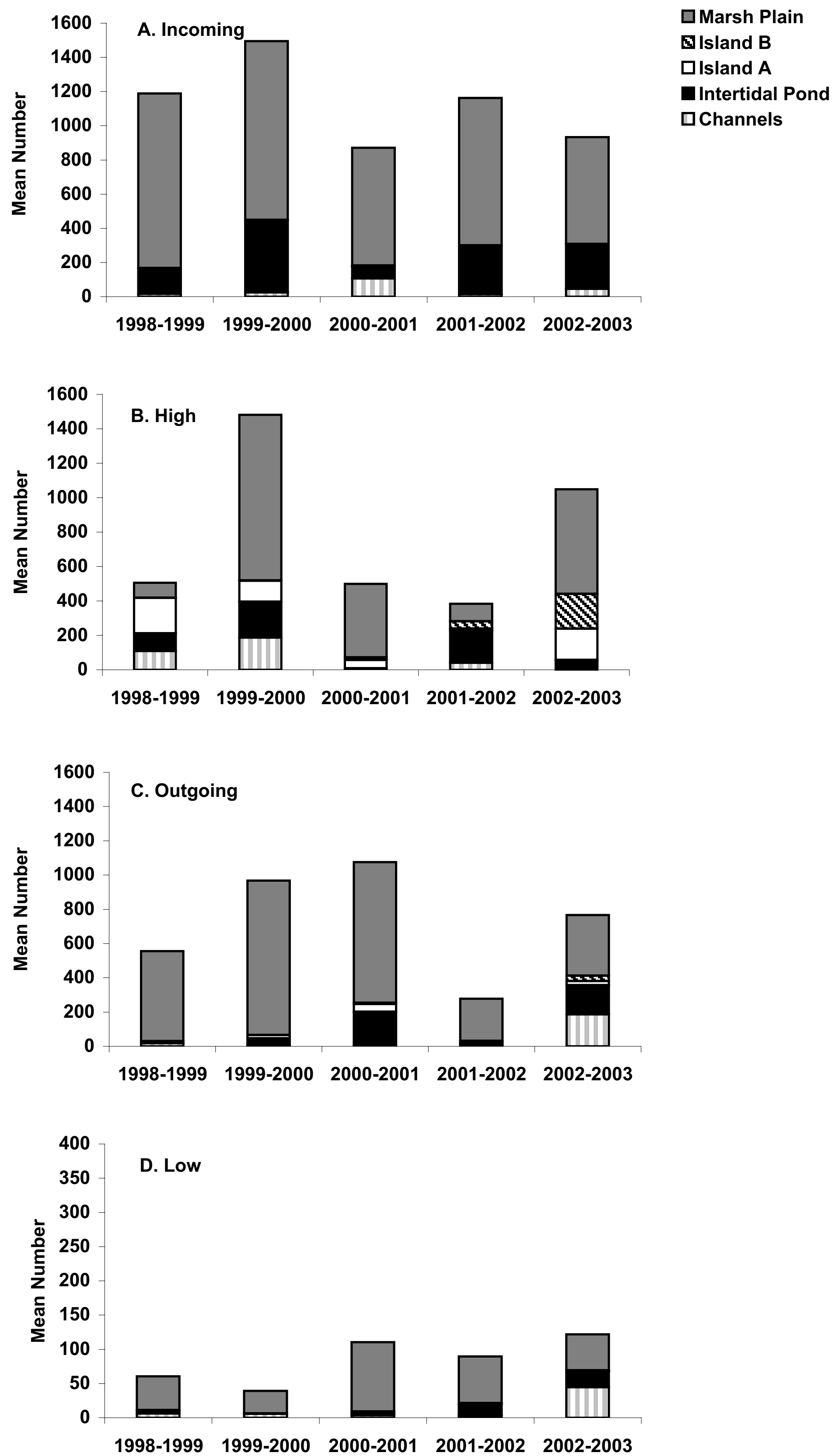

Figure 7. Mean abundance of shorebirds at five subareas of the Tidal Wetlands, 1998-2003. Note large difference in Low Tide y-axis.

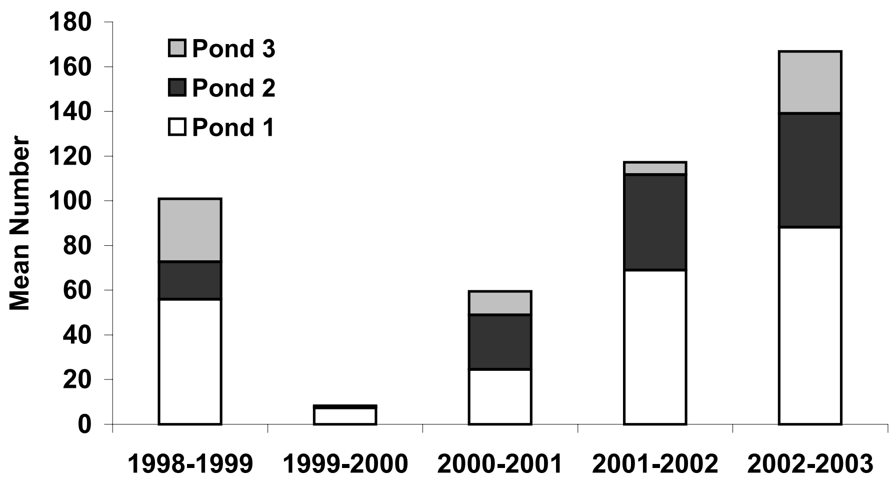

Figure 8. Mean abundance of shorebirds at three sub-areas of the Seasonal Ponds, 1998-2003.

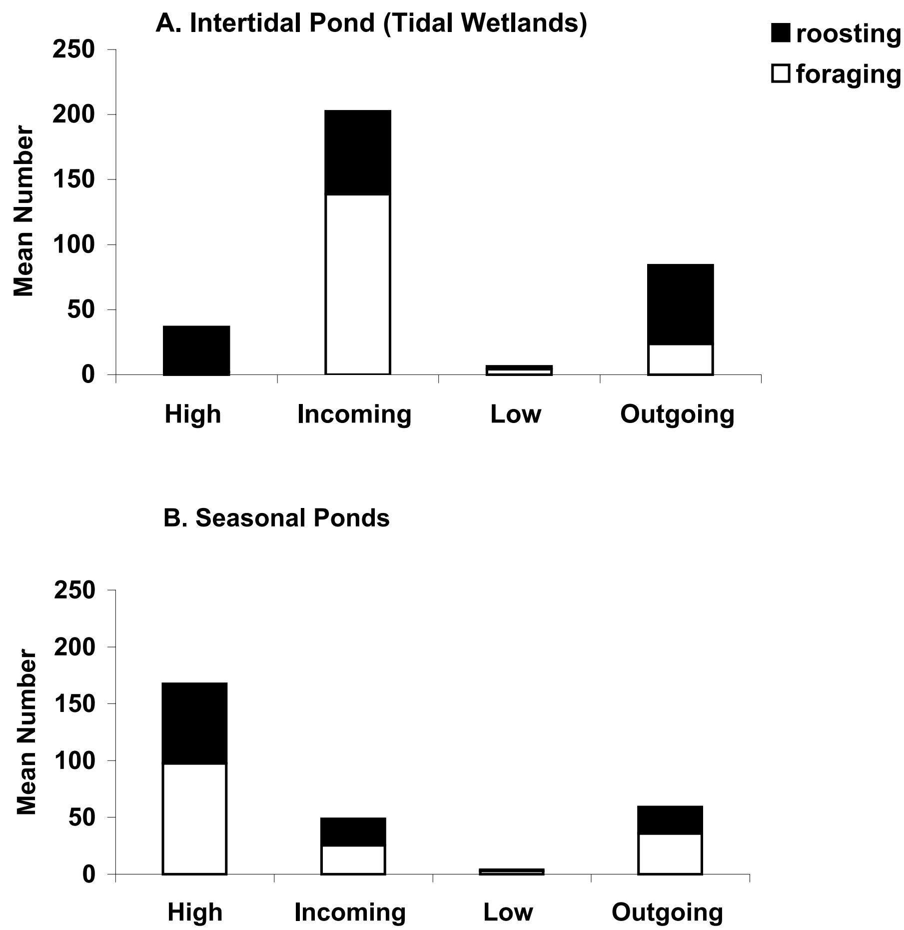

Figure 9. Mean number of shorebirds foraging and roosting at the Intertidal Pond and the Seasonal Ponds, 1998-2003.

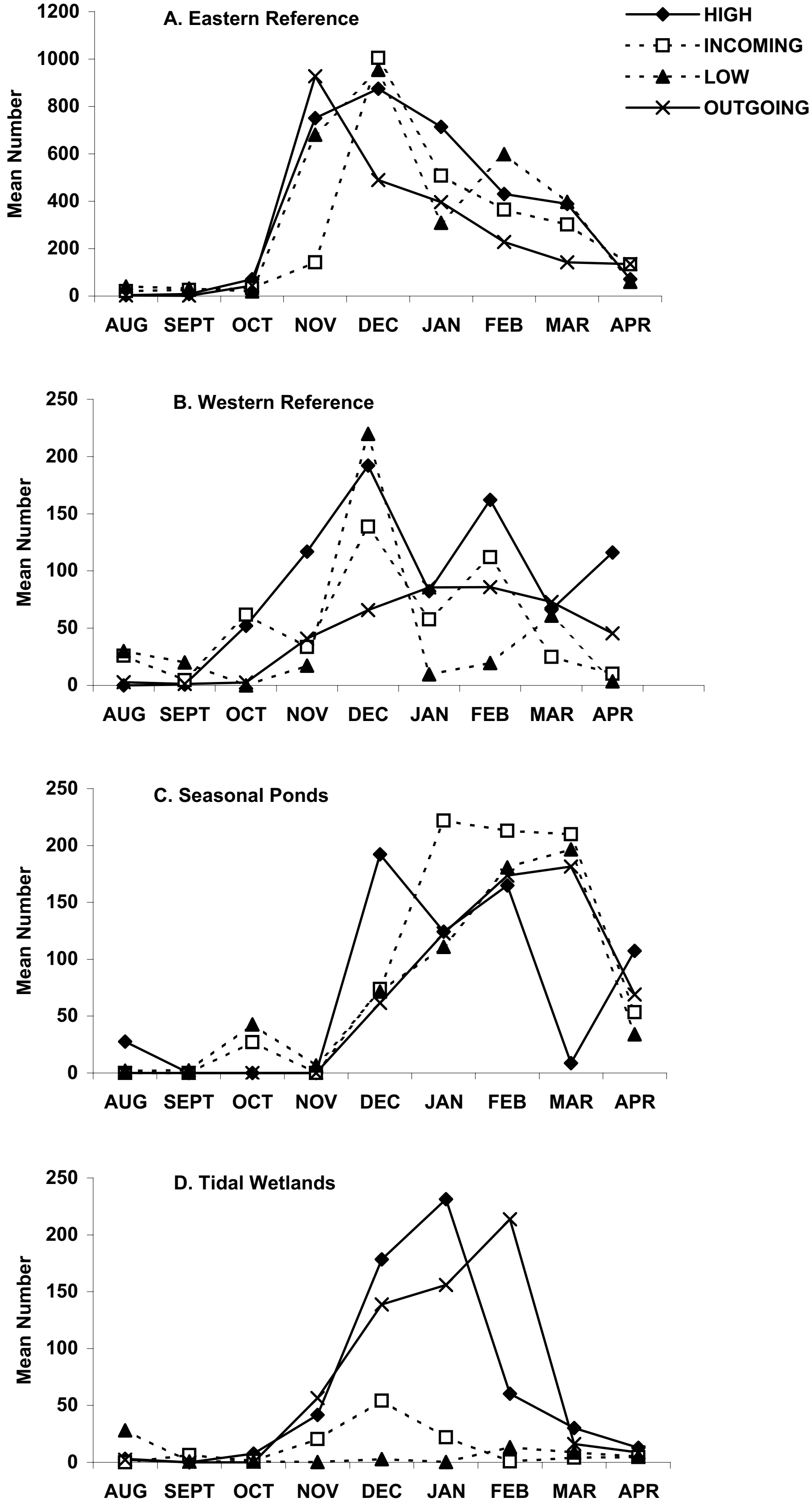

Figure 10. Mean monthly abundance of waterfowl at four tidal stages at four monitoring sites, 1998-2003. Note large difference in Eastern Reference y-axis.

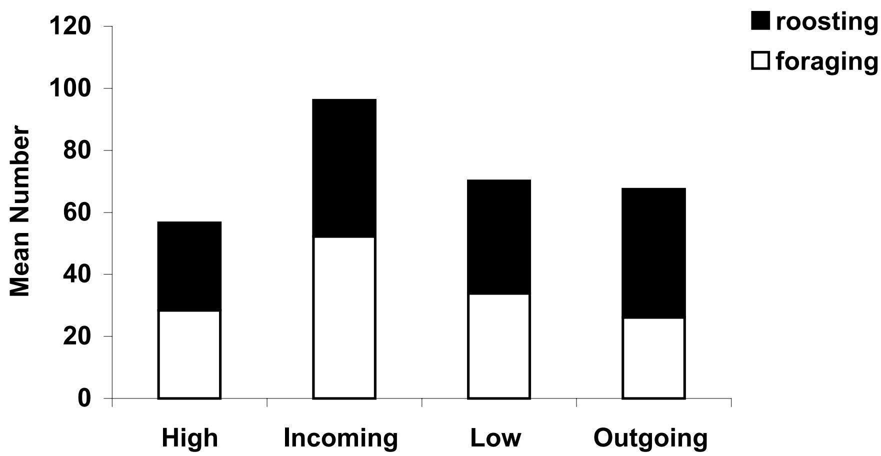

Figure 11. Mean number of waterfowl foraging at the Seasonal Ponds, 1998-2003.

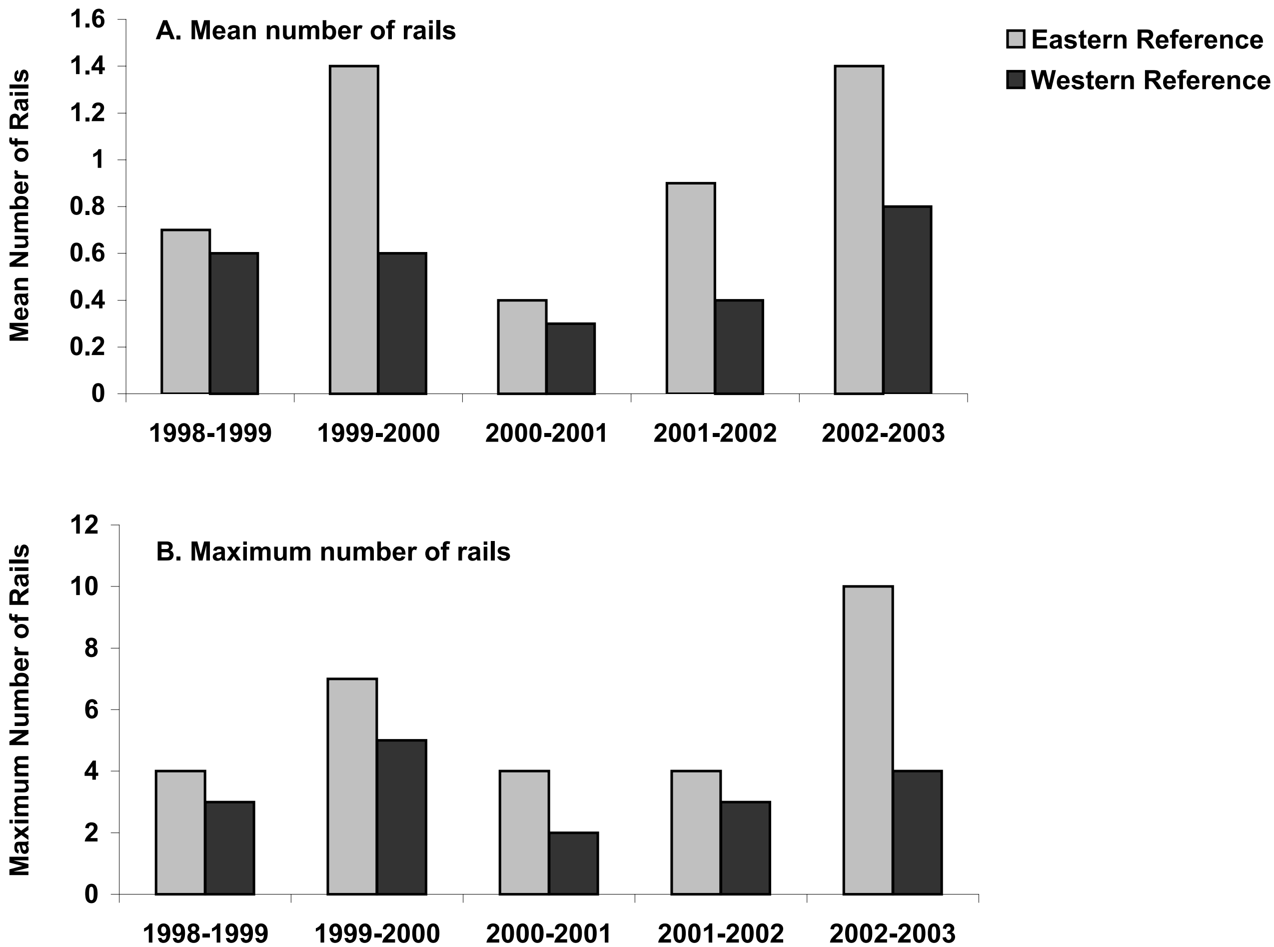

Figure 12. Mean (A) and maximum (B) abundance of Clapper Rails at the Eastern and Western Reference Sites, 1998-2003. Rails were directly observed or heard calling.

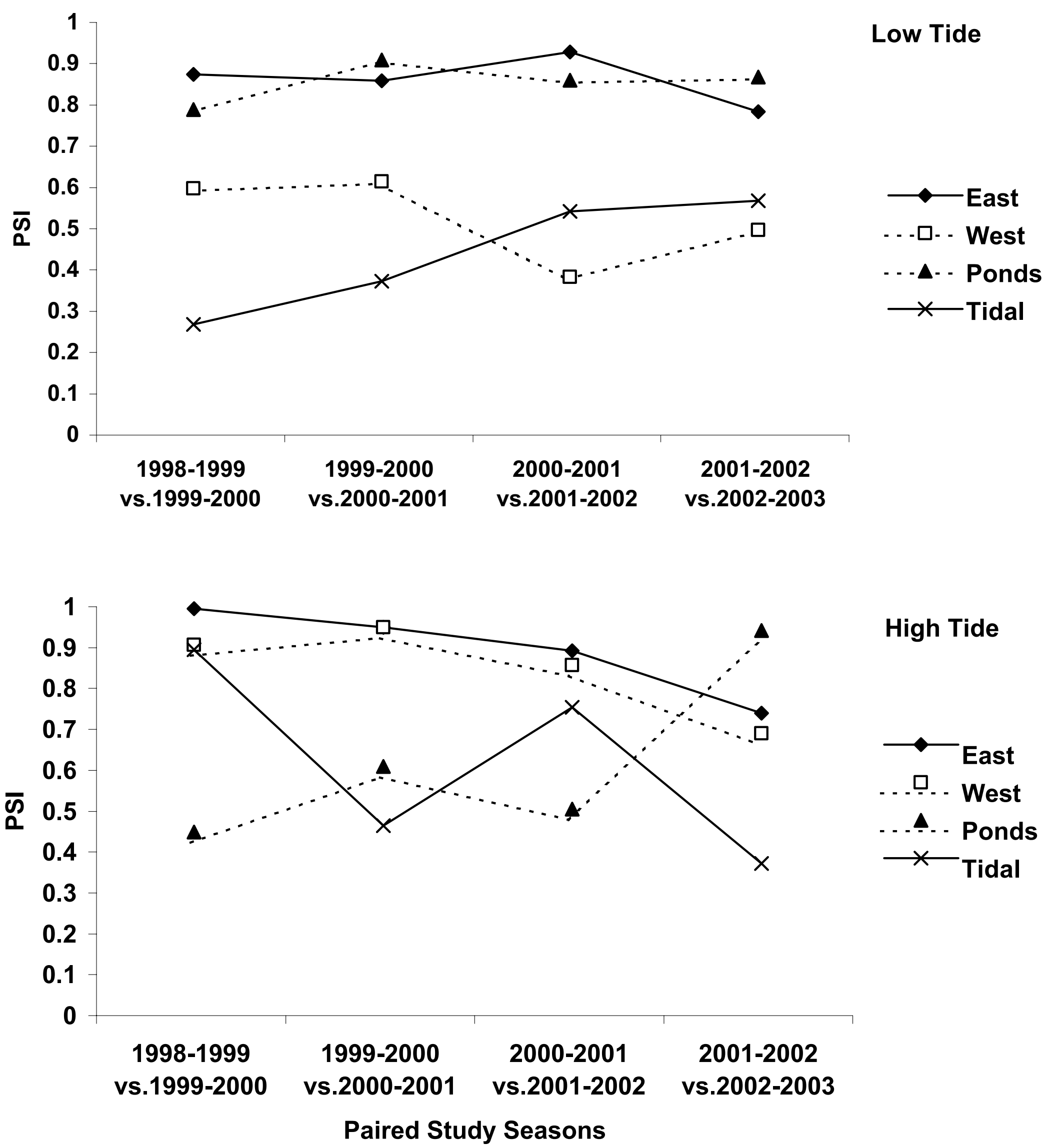

Figure 13. Percentage Similarity Indices (PSI) betwen avian communities in paired sequential years at the two Reference Sites (East and West) and the two Restoration Sites (Ponds and Tidal) at low and high tide. Low PSI values indicate dissimilar communities between years; high PSI values indicate similar avian communities.

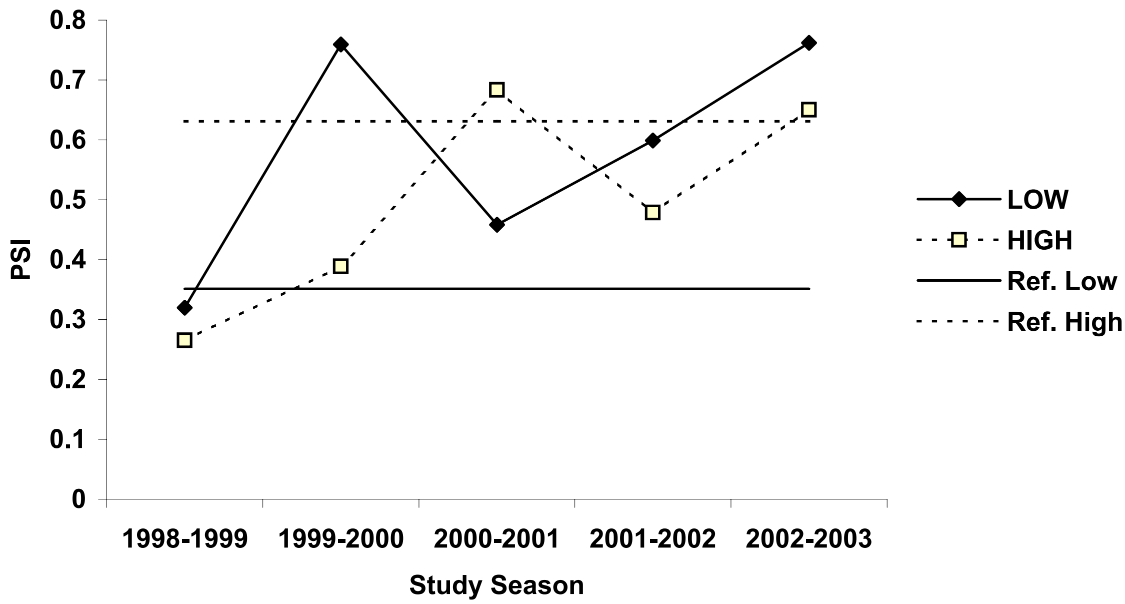

Figure 14. Mean Percentage Similarity Indices (PSI) bewteen avian communities in sequential years in the Reference Sites (combined; straight lines), and PSI between the Reference Sites (combined) and the Restoration Sites (combined), at high and low tide.

Appendix A. Scheduled waterbird surveys at the four monitoring sites, 1998-2003. Surveys in areas shaded in gray and in italics were not conducted.

Monitoring Year	Month	Survey Date	Location	Tide Stage
1998-1999	*October*		*Eastern Reference*	*High*
1998-1999	October	10/8/98	Seasonal Ponds	High
1998-1999	October	10/8/98	Tidal Wetlands	High
1998-1999	*October*		*Western Reference*	*High*
1998-1999	*October*		*Eastern Reference*	*Low*
1998-1999	October	10/17/98	Seasonal Ponds	Low
1998-1999	October	10/17/98	Tidal Wetlands	Low
1998-1999	*October*		*Western Reference*	*Low*
1998-1999	*October*		*Eastern Reference*	*Incoming*
1998-1999	October	10/18/98	Seasonal Ponds	Incoming
1998-1999	October	10/18/98	Tidal Wetlands	Incoming
1998-1999	*October*		*Western Reference*	*Incoming*
1998-1999	October	10/18/98	Eastern Reference	Outgoing
1998-1999	October	10/18/98	Seasonal Ponds	Outgoing
1998-1999	October	10/18/98	Tidal Wetlands	Outgoing
1998-1999	*October*		*Western Reference*	*Outgoing*
1998-1999	November	11/1/98	Eastern Reference	Low
1998-1999	November	11/1/98	Seasonal Ponds	Low
1998-1999	November	11/1/98	Tidal Wetlands	Low
1998-1999	November	11/1/98	Western Reference	Low
1998-1999	*November*		*Eastern Reference*	*High*
1998-1999	November	11/7/98	Seasonal Ponds	High
1998-1999	November	11/7/98	Tidal Wetlands	High
1998-1999	*November*		*Western Reference*	*High*
1998-1999	*November*		*Eastern Reference*	*Incoming*
1998-1999	*November*		*Seasonal Ponds*	*Incoming*
1998-1999	*November*		*Tidal Wetlands*	*Incoming*
1998-1999	*November*		*Western Reference*	*Incoming*
1998-1999	November	11/29/98	Eastern Reference	Outgoing
1998-1999	*November*		*Seasonal Ponds*	*Outgoing*
1998-1999	November	11/29/98	Tidal Wetlands	Outgoing
1998-1999	November	11/29/98	Western Reference	Outgoing
1998-1999	December	12/4/98	Eastern Reference	High
1998-1999	December	12/4/98	Seasonal Ponds	High
1998-1999	December	12/4/98	Tidal Wetlands	High
1998-1999	December	12/4/98	Western Reference	High
1998-1999	December	12/5/98	Eastern Reference	Incoming
1998-1999	December	12/5/98	Seasonal Ponds	Incoming
1998-1999	December	12/5/98	Tidal Wetlands	Incoming
1998-1999	December	12/5/98	Western Reference	Incoming
1998-1999	December	12/13/98	Eastern Reference	Low
1998-1999	December	12/13/98	Seasonal Ponds	Low
1998-1999	December	12/13/98	Tidal Wetlands	Low
1998-1999	December	12/13/98	Western Reference	Low
1998-1999	December	12/28/98	Eastern Reference	Outgoing
1998-1999	December	12/28/98	Seasonal Ponds	Outgoing
1998-1999	December	12/28/98	Tidal Wetlands	Outgoing
1998-1999	December	12/28/98	Western Reference	Outgoing

Monitoring Year	Month	Survey Date	Location	Tide Stage
1998-1999	January	1/2/99	Eastern Reference	High
1998-1999	January	1/2/99	Seasonal Ponds	High
1998-1999	January	1/2/99	Tidal Wetlands	High
1998-1999	January	1/2/99	Western Reference	High
1998-1999	January	1/3/99	Eastern Reference	Incoming
1998-1999	January	1/3/99	Seasonal Ponds	Incoming
1998-1999	January	1/3/99	Tidal Wetlands	Incoming
1998-1999	January	1/3/99	Western Reference	Incoming
1998-1999	January	1/16/99	Eastern Reference	Outgoing
1998-1999	January	1/16/99	Seasonal Ponds	Outgoing
1998-1999	January	1/16/99	Tidal Wetlands	Outgoing
1998-1999	January	1/16/99	Western Reference	Outgoing
1998-1999	January	1/29/99	Eastern Reference	Low
1998-1999	January	1/29/99	Seasonal Ponds	Low
1998-1999	January	1/29/99	Tidal Wetlands	Low
1998-1999	January	1/29/99	Western Reference	Low
1998-1999	February	2/1/99	Eastern Reference	Incoming
1998-1999	February	2/1/99	Seasonal Ponds	Incoming
1998-1999	February	2/1/99	Tidal Wetlands	Incoming
1998-1999	February	2/1/99	Western Reference	Incoming
1998-1999	February	2/12/99	Eastern Reference	Low
1998-1999	February	2/12/99	Seasonal Ponds	Low
1998-1999	February	2/12/99	Tidal Wetlands	Low
1998-1999	February	2/12/99	Western Reference	Low
1998-1999	February	2/13/99	Eastern Reference	High
1998-1999	February	2/13/99	Seasonal Ponds	High
1998-1999	February	2/13/99	Tidal Wetlands	High
1998-1999	February	2/13/99	Western Reference	High
1998-1999	February	2/13/99	Eastern Reference	Outgoing
1998-1999	February	2/13/99	Seasonal Ponds	Outgoing
1998-1999	February	2/13/99	Tidal Wetlands	Outgoing
1998-1999	February	2/13/99	Western Reference	Outgoing
1998-1999	March	3/1/99	Eastern Reference	High
1998-1999	March	3/1/99	Seasonal Ponds	High
1998-1999	March	3/1/99	Tidal Wetlands	High
1998-1999	March	3/1/99	Western Reference	High
1998-1999	March	3/13/99	Eastern Reference	Outgoing
1998-1999	March	3/13/99	Seasonal Ponds	Outgoing
1998-1999	March	3/13/99	Tidal Wetlands	Outgoing
1998-1999	March	3/13/99	Western Reference	Outgoing
1998-1999	March	3/14/99	Eastern Reference	Low
1998-1999	March	3/14/99	Seasonal Ponds	Low
1998-1999	March	3/14/99	Tidal Wetlands	Low
1998-1999	*March*		*Western Reference*	*Low*
1998-1999	March	3/19/99	Eastern Reference	Incoming
1998-1999	March	3/19/99	Seasonal Ponds	Incoming
1998-1999	March	3/19/99	Tidal Wetlands	Incoming
1998-1999	March	3/19/99	Western Reference	Incoming
1998-1999	April	4/11/99	Eastern Reference	Outgoing
1998-1999	April	4/11/99	Seasonal Ponds	Outgoing
1998-1999	April	4/11/99	Tidal Wetlands	Outgoing

Monitoring Year	Month	Survey Date	Location	Tide Stage
1998-1999	April	4/11/99	Western Reference	Outgoing
1998-1999	April	4/16/99	Eastern Reference	High
1998-1999	April	4/16/99	Seasonal Ponds	High
1998-1999	April	4/16/99	Tidal Wetlands	High
1998-1999	April	4/16/99	Western Reference	High
1998-1999	April	4/17/99	Eastern Reference	Incoming
1998-1999	*April*		*Seasonal Ponds*	*Incoming*
1998-1999	*April*		*Tidal Wetlands*	*Incoming*
1998-1999	April	4/17/99	Western Reference	Incoming
1998-1999	April	4/19/99	Eastern Reference	Low
1998-1999	April	4/19/99	Seasonal Ponds	Low
1998-1999	April	4/19/99	Tidal Wetlands	Low
1998-1999	April	4/19/99	Western Reference	Low
1999-2000	August	8/13/99	Eastern Reference	Incoming
1999-2000	August	8/13/99	Seasonal Ponds	Incoming
1999-2000	August	8/13/99	Tidal Wetlands	Incoming
1999-2000	August	8/13/99	Western Reference	Incoming
1999-2000	August	8/13/99	Eastern Reference	Low
1999-2000	*August*		*Seasonal Ponds*	*Low*
1999-2000	*August*		*Tidal Wetlands*	*Low*
1999-2000	August	8/13/99	Western Reference	Low
1999-2000	August	8/29/99	Eastern Reference	High
1999-2000	August	8/29/99	Seasonal Ponds	High
1999-2000	August	8/29/99	Tidal Wetlands	High
1999-2000	*August*		*Western Reference*	*High*
1999-2000	August	8/29/99	Eastern Reference	Outgoing
1999-2000	August	8/29/99	Seasonal Ponds	Outgoing
1999-2000	August	8/29/99	Tidal Wetlands	Outgoing
1999-2000	August	8/29/99	Western Reference	Outgoing
1999-2000	September	9/11/99	Eastern Reference	Incoming
1999-2000	*September*		*Seasonal Ponds*	*Incoming*
1999-2000	*September*		*Tidal Wetlands*	*Incoming*
1999-2000	September	9/11/99	Western Reference	Incoming
1999-2000	September	9/12/99	Eastern Reference	Low
1999-2000	September	9/12/99	Seasonal Ponds	Low
1999-2000	September	9/12/99	Tidal Wetlands	Low
1999-2000	September	9/12/99	Western Reference	Low
1999-2000	September	9/26/99	Eastern Reference	High
1999-2000	September	9/26/99	Seasonal Ponds	High
1999-2000	September	9/26/99	Tidal Wetlands	High
1999-2000	September	9/26/99	Western Reference	High
1999-2000	September	9/26/99	Eastern Reference	Outgoing
1999-2000	September	9/26/99	Seasonal Ponds	Outgoing
1999-2000	September	9/26/99	Tidal Wetlands	Outgoing
1999-2000	September	9/26/99	Western Reference	Outgoing
1999-2000	October	10/10/99	Eastern Reference	Incoming
1999-2000	October	10/10/99	Seasonal Ponds	Incoming
1999-2000	October	10/10/99	Tidal Wetlands	Incoming
1999-2000	October	10/10/99	Western Reference	Incoming
1999-2000	October	10/22/99	Eastern Reference	Low
1999-2000	October	10/22/99	Seasonal Ponds	Low

Monitoring Year	Month	Survey Date	Location	Tide Stage
1999-2000	October	10/22/99	Tidal Wetlands	Low
1999-2000	October	10/22/99	Western Reference	Low
1999-2000	October	10/24/99	Eastern Reference	High
1999-2000	October	10/24/99	Seasonal Ponds	High
1999-2000	October	10/24/99	Tidal Wetlands	High
1999-2000	October	10/24/99	Western Reference	High
1999-2000	October	10/24/99	Eastern Reference	Outgoing
1999-2000	October	10/24/99	Seasonal Ponds	Outgoing
1999-2000	October	10/24/99	Tidal Wetlands	Outgoing
1999-2000	October	10/24/99	Western Reference	Outgoing
1999-2000	November	11/7/99	Eastern Reference	Incoming
1999-2000	November	11/7/99	Seasonal Ponds	Incoming
1999-2000	November	11/7/99	Tidal Wetlands	Incoming
1999-2000	November	11/7/99	Western Reference	Incoming
1999-2000	November	11/20/99	Eastern Reference	Low
1999-2000	November	11/20/99	Seasonal Ponds	Low
1999-2000	November	11/20/99	Tidal Wetlands	Low
1999-2000	November	11/20/99	Western Reference	Low
1999-2000	November	11/21/99	Eastern Reference	Outgoing
1999-2000	November	11/21/99	Seasonal Ponds	Outgoing
1999-2000	November	11/21/99	Tidal Wetlands	Outgoing
1999-2000	November	11/21/99	Western Reference	Outgoing
1999-2000	November	11/24/99	Eastern Reference	High
1999-2000	November	11/24/99	Seasonal Ponds	High
1999-2000	November	11/24/99	Tidal Wetlands	High
1999-2000	November	11/24/99	Western Reference	High
1999-2000	December	12/5/99	Eastern Reference	Outgoing
1999-2000	December	12/5/99	Seasonal Ponds	Outgoing
1999-2000	December	12/5/99	Tidal Wetlands	Outgoing
1999-2000	December	12/5/99	Western Reference	Outgoing
1999-2000	December	12/19/99	Eastern Reference	Low
1999-2000	December	12/19/99	Seasonal Ponds	Low
1999-2000	December	12/19/99	Tidal Wetlands	Low
1999-2000	December	12/19/99	Western Reference	Low
1999-2000	December	12/22/99	Eastern Reference	High
1999-2000	December	12/22/99	Seasonal Ponds	High
1999-2000	December	12/22/99	Tidal Wetlands	High
1999-2000	December	12/22/99	Western Reference	High
1999-2000	December	12/30/99	Eastern Reference	Incoming
1999-2000	*December*		*Seasonal Ponds*	*Incoming*
1999-2000	December	12/30/99	Tidal Wetlands	Incoming
1999-2000	December	12/30/99	Western Reference	Incoming
1999-2000	January	1/15/00	Eastern Reference	Incoming
1999-2000	January	1/15/00	Seasonal Ponds	Incoming
1999-2000	January	1/15/00	Tidal Wetlands	Incoming
1999-2000	January	1/15/00	Western Reference	Incoming
1999-2000	January	1/18/00	Eastern Reference	Low
1999-2000	January	1/18/00	Seasonal Ponds	Low
1999-2000	January	1/18/00	Tidal Wetlands	Low
1999-2000	January	1/18/00	Western Reference	Low
1999-2000	January	1/20/00	Eastern Reference	High

Monitoring Year	Month	Survey Date	Location	Tide Stage
1999-2000	January	1/20/00	Seasonal Ponds	High
1999-2000	January	1/20/00	Tidal Wetlands	High
1999-2000	January	1/20/00	Western Reference	High
1999-2000	January	1/22/00	Eastern Reference	Outgoing
1999-2000	January	1/22/00	Seasonal Ponds	Outgoing
1999-2000	January	1/22/00	Tidal Wetlands	Outgoing
1999-2000	January	1/22/00	Western Reference	Outgoing
1999-2000	February	2/15/00	Eastern Reference	Low
1999-2000	February	2/15/00	Seasonal Ponds	Low
1999-2000	February	2/15/00	Tidal Wetlands	Low
1999-2000	February	2/15/00	Western Reference	Low
1999-2000	February	2/18/00	Eastern Reference	High
1999-2000	February	2/18/00	Seasonal Ponds	High
1999-2000	February	2/18/00	Tidal Wetlands	High
1999-2000	February	2/18/00	Western Reference	High
1999-2000	February	2/20/00	Eastern Reference	Outgoing
1999-2000	February	2/20/00	Seasonal Ponds	Outgoing
1999-2000	February	2/20/00	Tidal Wetlands	Outgoing
1999-2000	February	2/20/00	Western Reference	Outgoing
1999-2000	February	2/27/00	Eastern Reference	Incoming
1999-2000	February	2/27/00	Seasonal Ponds	Incoming
1999-2000	February	2/27/00	Tidal Wetlands	Incoming
1999-2000	February	2/27/00	Western Reference	Incoming
1999-2000	March	3/5/00	Eastern Reference	Outgoing
1999-2000	March	3/5/00	Seasonal Ponds	Outgoing
1999-2000	March	3/5/00	Tidal Wetlands	Outgoing
1999-2000	March	3/5/00	Western Reference	Outgoing
1999-2000	March	3/12/00	Eastern Reference	Incoming
1999-2000	March	3/12/00	Seasonal Ponds	Incoming
1999-2000	March	3/12/00	Tidal Wetlands	Incoming
1999-2000	March	3/12/00	Western Reference	Incoming
1999-2000	March	3/17/00	Eastern Reference	High
1999-2000	March	3/17/00	Seasonal Ponds	High
1999-2000	March	3/17/00	Tidal Wetlands	High
1999-2000	March	3/17/00	Western Reference	High
1999-2000	March	3/18/00	Eastern Reference	Low
1999-2000	March	3/18/00	Seasonal Ponds	Low
1999-2000	March	3/18/00	Tidal Wetlands	Low
1999-2000	March	3/18/00	Western Reference	Low
1999-2000	April	4/2/00	Eastern Reference	High
1999-2000	April	4/2/00	Seasonal Ponds	High
1999-2000	April	4/2/00	Tidal Wetlands	High
1999-2000	April	4/2/00	Western Reference	High
1999-2000	*April*		*Eastern Reference*	*Low*
1999-2000	April	4/8/00	Seasonal Ponds	Low
1999-2000	April	4/8/00	Tidal Wetlands	Low
1999-2000	*April*		*Western Reference*	*Low*
1999-2000	April	4/11/00	Eastern Reference	Incoming
1999-2000	April	4/11/00	Seasonal Ponds	Incoming
1999-2000	April	4/11/00	Tidal Wetlands	Incoming
1999-2000	April	4/11/00	Western Reference	Incoming

Monitoring Year	Month	Survey Date	Location	Tide Stage
1999-2000	April	4/16/00	Eastern Reference	Outgoing
1999-2000	April	4/16/00	Seasonal Ponds	Outgoing
1999-2000	April	4/16/00	Tidal Wetlands	Outgoing
1999-2000	April	4/16/00	Western Reference	Outgoing
2000-2001	August	8/5/00	Eastern Reference	High
2000-2001	August	8/5/00	Seasonal Ponds	High
2000-2001	August	8/5/00	Tidal Wetlands	High
2000-2001	August	8/5/00	Western Reference	High
2000-2001	*August*		*Eastern Reference*	*Incoming*
2000-2001	August	8/27/00	Seasonal Ponds	Incoming
2000-2001	August	8/27/00	Tidal Wetlands	Incoming
2000-2001	August	8/27/00	Western Reference	Incoming
2000-2001	August	8/27/00	Eastern Reference	Outgoing
2000-2001	August	8/27/00	Seasonal Ponds	Outgoing
2000-2001	August	8/27/00	Tidal Wetlands	Outgoing
2000-2001	August	8/27/00	Western Reference	Outgoing
2000-2001	August	8/30/00	Eastern Reference	Low
2000-2001	August	8/30/00	Seasonal Ponds	Low
2000-2001	August	8/30/00	Tidal Wetlands	Low
2000-2001	August	8/30/00	Western Reference	Low
2000-2001	September	9/1/00	Eastern Reference	Low
2000-2001	*September*		*Seasonal Ponds*	*Low*
2000-2001	*September*		*Tidal Wetlands*	*Low*
2000-2001	September	9/1/00	Western Reference	Low
2000-2001	September	9/16/00	Eastern Reference	Outgoing
2000-2001	*September*		*Seasonal Ponds*	*Outgoing*
2000-2001	*September*		*Tidal Wetlands*	*Outgoing*
2000-2001	September	9/16/00	Western Reference	Outgoing
2000-2001	September	9/29/00	Eastern Reference	High
2000-2001	September	9/29/00	Seasonal Ponds	High
2000-2001	September	9/29/00	Tidal Wetlands	High
2000-2001	September	9/29/00	Western Reference	High
2000-2001	September	9/30/00	Eastern Reference	Incoming
2000-2001	September	9/30/00	Seasonal Ponds	Incoming
2000-2001	September	9/30/00	Tidal Wetlands	Incoming
2000-2001	September	9/30/00	Western Reference	Incoming
2000-2001	October	10/1/00	Eastern Reference	Low
2000-2001	October	10/1/00	Seasonal Ponds	Low
2000-2001	October	10/1/00	Tidal Wetlands	Low
2000-2001	*October*		*Western Reference*	*Low*
2000-2001	October	10/14/00	Eastern Reference	Incoming
2000-2001	October	10/14/00	Tidal Wetlands	Incoming
2000-2001	*October*		*Seasonal Ponds*	*Incoming*
2000-2001	October	10/14/00	Western Reference	Incoming
2000-2001	October	10/15/00	Eastern Reference	Outgoing
2000-2001	October	10/15/00	Seasonal Ponds	Outgoing
2000-2001	October	10/15/00	Tidal Wetlands	Outgoing
2000-2001	October	10/15/00	Western Reference	Outgoing
2000-2001	October	10/27/00	Eastern Reference	High
2000-2001	*October*		*Seasonal Ponds*	*High*
2000-2001	October	10/27/00	Tidal Wetlands	High

Monitoring Year	Month	Survey Date	Location	Tide Stage
2000-2001	October	10/27/00	Western Reference	High
2000-2001	November	11/10/00	Eastern Reference	High
2000-2001	November	11/10/00	Seasonal Ponds	High
2000-2001	November	11/10/00	Tidal Wetlands	High
2000-2001	November	11/10/00	Western Reference	High
2000-2001	November	11/19/00	Eastern Reference	Incoming
2000-2001	November	11/19/00	Seasonal Ponds	Incoming
2000-2001	November	11/19/00	Tidal Wetlands	Incoming
2000-2001	November	11/19/00	Western Reference	Incoming
2000-2001	November	11/20/00	Eastern Reference	Low
2000-2001	November	11/20/00	Seasonal Ponds	Low
2000-2001	November	11/20/00	Tidal Wetlands	Low
2000-2001	November	11/20/00	Western Reference	Low
2000-2001	November	11/25/00	Eastern Reference	Outgoing
2000-2001	*November*		*Seasonal Ponds*	*Outgoing*
2000-2001	November	11/25/00	Tidal Wetlands	Outgoing
2000-2001	November	11/25/00	Western Reference	Outgoing
2000-2001	December	12/7/00	Eastern Reference	Low
2000-2001	December	12/7/00	Seasonal Ponds	Low
2000-2001	December	12/7/00	Tidal Wetlands	Low
2000-2001	December	12/7/00	Western Reference	Low
2000-2001	December	12/9/00	Eastern Reference	Outgoing
2000-2001	December	12/9/00	Seasonal Ponds	Outgoing
2000-2001	December	12/9/00	Tidal Wetlands	Outgoing
2000-2001	December	12/9/00	Western Reference	Outgoing
2000-2001	December	12/10/00	Eastern Reference	High
2000-2001	*December*		*Seasonal Ponds*	*High*
2000-2001	December	12/10/00	Tidal Wetlands	High
2000-2001	December	12/10/00	Western Reference	High
2000-2001	December	12/19/00	Eastern Reference	Incoming
2000-2001	December	12/19/00	Seasonal Ponds	Incoming
2000-2001	December	12/19/00	Tidal Wetlands	Incoming
2000-2001	December	12/19/00	Western Reference	Incoming
2000-2001	January	1/6/01	Eastern Reference	Low
2000-2001	January	1/6/01	Seasonal Ponds	Low
2000-2001	January	1/6/01	Tidal Wetlands	Low
2000-2001	January	1/6/01	Western Reference	Low
2000-2001	January	1/10/01	Eastern Reference	High
2000-2001	January	1/10/01	Seasonal Ponds	High
2000-2001	January	1/10/01	Tidal Wetlands	High
2000-2001	January	1/10/01	Western Reference	High
2000-2001	January	1/20/01	Eastern Reference	Outgoing
2000-2001	January	1/20/01	Seasonal Ponds	Outgoing
2000-2001	January	1/20/01	Tidal Wetlands	Outgoing
2000-2001	January	1/20/01	Western Reference	Outgoing
2000-2001	January	1/28/01	Eastern Reference	Incoming
2000-2001	*January*		*Seasonal Ponds*	*Incoming*
2000-2001	*January*		*Tidal Wetlands*	*Incoming*
2000-2001	January	1/28/01	Western Reference	Incoming
2000-2001	February	2/3/01	Eastern Reference	Outgoing
2000-2001	February	2/3/01	Seasonal Ponds	Outgoing

Monitoring Year	Month	Survey Date	Location	Tide Stage
2000-2001	February	2/3/01	Tidal Wetlands	Outgoing
2000-2001	February	2/3/01	Western Reference	Outgoing
2000-2001	February	2/4/01	Eastern Reference	Low
2000-2001	February	2/4/01	Seasonal Ponds	Low
2000-2001	February	2/4/01	Tidal Wetlands	Low
2000-2001	February	2/4/01	Western Reference	Low
2000-2001	February	2/8/01	Eastern Reference	High
2000-2001	February	2/8/01	Seasonal Ponds	High
2000-2001	February	2/8/01	Tidal Wetlands	High
2000-2001	February	2/8/01	Western Reference	High
2000-2001	February	2/28/01	Eastern Reference	Incoming
2000-2001	February	2/28/01	Seasonal Ponds	Incoming
2000-2001	February	2/28/01	Tidal Wetlands	Incoming
2000-2001	February	2/28/01	Western Reference	Incoming
2000-2001	March	3/4/01	Eastern Reference	Low
2000-2001	March	3/4/01	Seasonal Ponds	Low
2000-2001	March	3/4/01	Tidal Wetlands	Low
2000-2001	March	3/4/01	Western Reference	Low
2000-2001	March	3/8/01	Eastern Reference	High
2000-2001	March	3/8/01	Seasonal Ponds	High
2000-2001	March	3/8/01	Tidal Wetlands	High
2000-2001	March	3/8/01	Western Reference	High
2000-2001	March	3/9/01	Eastern Reference	Outgoing
2000-2001	March	3/9/01	Seasonal Ponds	Outgoing
2000-2001	March	3/9/01	Tidal Wetlands	Outgoing
2000-2001	March	3/9/01	Western Reference	Outgoing
2000-2001	March	3/21/01	Eastern Reference	Incoming
2000-2001	March	3/31/01	Seasonal Ponds	Incoming
2000-2001	March	3/31/01	Tidal Wetlands	Incoming
2000-2001	March	3/31/01	Western Reference	Incoming
2000-2001	*April*		*Eastern Reference*	*High*
2000-2001	April	4/10/01	Seasonal Ponds	High
2000-2001	April	4/10/01	Tidal Wetlands	High
2000-2001	April	4/10/01	Western Reference	High
2000-2001	April	4/26/01	Eastern Reference	Outgoing
2000-2001	April	4/26/01	Seasonal Ponds	Outgoing
2000-2001	April	4/26/01	Tidal Wetlands	Outgoing
2000-2001	April	4/26/01	Western Reference	Outgoing
2000-2001	April	4/28/01	Eastern Reference	Low
2000-2001	April	4/28/01	Seasonal Ponds	Low
2000-2001	April	4/28/01	Tidal Wetlands	Low
2000-2001	April	4/28/01	Western Reference	Low
2000-2001	April	4/29/01	Eastern Reference	Incoming
2000-2001	April	4/29/01	Seasonal Ponds	Incoming
2000-2001	April	4/29/01	Tidal Wetlands	Incoming
2000-2001	April	4/29/01	Western Reference	Incoming
2001-2002	August	8/8/01	Eastern Reference	Low
2001-2002	August	8/8/01	Seasonal Ponds	Low
2001-2002	August	8/8/01	Tidal Wetlands	Low
2001-2002	August	8/8/01	Western Reference	Low
2001-2002	August	8/19/01	Eastern Reference	Incoming

Monitoring Year	Month	Survey Date	Location	Tide Stage
2001-2002	*August*		*Seasonal Ponds*	*Incoming*
2001-2002	August	8/19/01	Tidal Wetlands	Incoming
2001-2002	*August*		*Western Reference*	*Incoming*
2001-2002	August	8/20/01	Eastern Reference	Outgoing
2001-2002	August	8/20/01	Seasonal Ponds	Outgoing
2001-2002	August	8/20/01	Tidal Wetlands	Outgoing
2001-2002	August	8/20/01	Western Reference	Outgoing
2001-2002	August	8/25/01	Eastern Reference	High
2001-2002	August	8/25/01	Seasonal Ponds	High
2001-2002	August	8/25/01	Tidal Wetlands	High
2001-2002	August	8/25/01	Western Reference	High
2001-2002	September	9/16/01	Eastern Reference	Incoming
2001-2002	September	9/16/01	Seasonal Ponds	Incoming
2001-2002	September	9/16/01	Tidal Wetlands	Incoming
2001-2002	September	9/16/01	Western Reference	Incoming
2001-2002	September	9/19/01	Eastern Reference	High
2001-2002	*September*		*Seasonal Ponds*	*High*
2001-2002	September	9/19/01	Tidal Wetlands	High
2001-2002	September	9/19/01	Western Reference	High
2001-2002	September	9/23/01	Eastern Reference	Low
2001-2002	September	9/23/01	Seasonal Ponds	Low
2001-2002	September	9/23/01	Tidal Wetlands	Low
2001-2002	September	9/23/01	Western Reference	Low
2001-2002	September	9/29/01	Eastern Reference	Outgoing
2001-2002	September	9/29/01	Seasonal Ponds	Outgoing
2001-2002	September	9/29/01	Tidal Wetlands	Outgoing
2001-2002	September	9/29/01	Western Reference	Outgoing
2001-2002	October	10/15/01	Eastern Reference	Outgoing
2001-2002	*October*		*Seasonal Ponds*	*Outgoing*
2001-2002	October	10/15/01	Tidal Wetlands	Outgoing
2001-2002	October	10/15/01	Western Reference	Outgoing
2001-2002	October	10/19/01	Eastern Reference	Incoming
2001-2002	October	10/19/01	Seasonal Ponds	Incoming
2001-2002	October	10/19/01	Tidal Wetlands	Incoming
2001-2002	October	10/19/01	Western Reference	Incoming
2001-2002	October	10/20/01	Eastern Reference	High
2001-2002	October	10/20/01	Seasonal Ponds	High
2001-2002	October	10/20/01	Tidal Wetlands	High
2001-2002	October	10/20/01	Western Reference	High
2001-2002	October	10/28/01	Eastern Reference	Low
2001-2002	October	10/28/01	Seasonal Ponds	Low
2001-2002	October	10/28/01	Tidal Wetlands	Low
2001-2002	October	10/28/01	Western Reference	Low
2001-2002	November	11/3/01	Eastern Reference	Incoming
2001-2002	November	11/3/01	Seasonal Ponds	Incoming
2001-2002	November	11/3/01	Tidal Wetlands	Incoming
2001-2002	November	11/3/01	Western Reference	Incoming
2001-2002	*November*		*Eastern Reference*	*High*
2001-2002	November	11/14/01	Seasonal Ponds	High
2001-2002	November	11/14/01	Tidal Wetlands	High
2001-2002	November	11/14/01	Western Reference	High

Monitoring Year	Month	Survey Date	Location	Tide Stage
2001-2002	November	11/15/01	Eastern Reference	Outgoing
2001-2002	November	11/15/01	Seasonal Ponds	Outgoing
2001-2002	November	11/15/01	Tidal Wetlands	Outgoing
2001-2002	November	11/15/01	Western Reference	Outgoing
2001-2002	*November*		*Eastern Reference*	*Low*
2001-2002	November	11/25/01	Seasonal Ponds	Low
2001-2002	November	11/25/01	Tidal Wetlands	Low
2001-2002	*November*		*Western Reference*	*Low*
2001-2002	*December*		*Eastern Reference*	*Low*
2001-2002	*December*		*Seasonal Ponds*	*Low*
2001-2002	*December*		*Tidal Wetlands*	*Low*
2001-2002	December	12/9/01	Western Reference	Low
2001-2002	December	12/19/01	Eastern Reference	Incoming
2001-2002	December	12/19/01	Seasonal Ponds	Incoming
2001-2002	December	12/19/01	Tidal Wetlands	Incoming
2001-2002	December	12/19/01	Western Reference	Incoming
2001-2002	December	12/28/01	Eastern Reference	Outgoing
2001-2002	December	12/28/01	Seasonal Ponds	Outgoing
2001-2002	December	12/28/01	Tidal Wetlands	Outgoing
2001-2002	December	12/28/01	Western Reference	Outgoing
2001-2002	December	12/29/01	Eastern Reference	High
2001-2002	December	12/29/01	Seasonal Ponds	High
2001-2002	December	12/29/01	Tidal Wetlands	High
2001-2002	December	12/29/01	Western Reference	High
2001-2002	January	1/6/02	Eastern Reference	Incoming
2001-2002	January	1/6/02	Seasonal Ponds	Incoming
2001-2002	January	1/6/02	Tidal Wetlands	Incoming
2001-2002	January	1/6/02	Western Reference	Incoming
2001-2002	January	1/10/02	Eastern Reference	Outgoing
2001-2002	January	1/10/02	Seasonal Ponds	Outgoing
2001-2002	January	1/10/02	Tidal Wetlands	Outgoing
2001-2002	January	1/10/02	Western Reference	Outgoing
2001-2002	January	1/12/02	Eastern Reference	High
2001-2002	January	1/12/02	Seasonal Ponds	High
2001-2002	January	1/12/02	Tidal Wetlands	High
2001-2002	January	1/12/02	Western Reference	High
2001-2002	January	1/23/02	Eastern Reference	Low
2001-2002	January	1/23/02	Seasonal Ponds	Low
2001-2002	January	1/23/02	Tidal Wetlands	Low
2001-2002	January	1/23/02	Western Reference	Low
2001-2002	February	2/3/02	Eastern Reference	Incoming
2001-2002	February	2/3/02	Seasonal Ponds	Incoming
2001-2002	February	2/3/02	Tidal Wetlands	Incoming
2001-2002	February	2/3/02	Western Reference	Incoming
2001-2002	February	2/7/02	Eastern Reference	Low
2001-2002	February	2/7/02	Seasonal Ponds	Low
2001-2002	February	2/7/02	Tidal Wetlands	Low
2001-2002	February	2/7/02	Western Reference	Low
2001-2002	February	2/9/02	Eastern Reference	Outgoing
2001-2002	February	2/9/02	Seasonal Ponds	Outgoing
2001-2002	February	2/9/02	Tidal Wetlands	Outgoing

Monitoring Year	Month	Survey Date	Location	Tide Stage
2001-2002	February	2/9/02	Western Reference	Outgoing
2001-2002	February	2/26/02	Eastern Reference	High
2001-2002	February	2/26/02	Seasonal Ponds	High
2001-2002	February	2/26/02	Tidal Wetlands	High
2001-2002	February	2/26/02	Western Reference	High
2001-2002	March	3/1/02	Eastern Reference	High
2001-2002	March	3/1/02	Seasonal Ponds	High
2001-2002	March	3/1/02	Tidal Wetlands	High
2001-2002	March	3/1/02	Western Reference	High
2001-2002	March	3/9/02	Eastern Reference	Low
2001-2002	March	3/9/02	Seasonal Ponds	Low
2001-2002	March	3/9/02	Tidal Wetlands	Low
2001-2002	March	3/9/02	Western Reference	Low
2001-2002	March	3/14/02	Eastern Reference	Outgoing
2001-2002	March	3/14/02	Seasonal Ponds	Outgoing
2001-2002	March	3/14/02	Tidal Wetlands	Outgoing
2001-2002	March	3/14/02	Western Reference	Outgoing
2001-2002	March	3/23/02	Eastern Reference	Incoming
2001-2002	March	3/23/02	Seasonal Ponds	Incoming
2001-2002	March	3/23/02	Tidal Wetlands	Incoming
2001-2002	March	3/23/02	Western Reference	Incoming
2001-2002	April	4/2/02	Eastern Reference	Incoming
2001-2002	April	4/2/02	Seasonal Ponds	Incoming
2001-2002	April	4/2/02	Tidal Wetlands	Incoming
2001-2002	April	4/2/02	Western Reference	Incoming
2001-2002	April	4/6/02	Eastern Reference	Outgoing
2001-2002	April	4/6/02	Seasonal Ponds	Outgoing
2001-2002	April	4/6/02	Tidal Wetlands	Outgoing
2001-2002	April	4/6/02	Western Reference	Outgoing
2001-2002	April	4/21/02	Eastern Reference	Low
2001-2002	April	4/21/02	Seasonal Ponds	Low
2001-2002	April	4/21/02	Tidal Wetlands	Low
2001-2002	April	4/21/02	Western Reference	Low
2001-2002	April	4/24/02	Eastern Reference	High
2001-2002	April	4/24/02	Seasonal Ponds	High
2001-2002	April	4/24/02	Tidal Wetlands	High
2001-2002	April	4/24/02	Western Reference	High
2002-2003	August	8/8/02	Eastern Reference	Incoming
2002-2003	August	8/8/02	Seasonal Ponds	Incoming
2002-2003	August	8/8/02	Tidal Wetlands	Incoming
2002-2003	August	8/8/02	Western Reference	Incoming
2002-2003	August	8/11/02	Eastern Reference	Outgoing
2002-2003	August	8/11/02	Seasonal Ponds	Outgoing
2002-2003	August	8/11/02	Tidal Wetlands	Outgoing
2002-2003	August	8/11/02	Western Reference	Outgoing
2002-2003	August	8/13/02	Eastern Reference	High
2002-2003	August	8/13/02	Seasonal Ponds	High
2002-2003	August	8/13/02	Tidal Wetlands	High
2002-2003	August	8/13/02	Western Reference	High
2002-2003	August	8/24/02	Eastern Reference	Low
2002-2003	*August*		*Seasonal Ponds*	*Low*

Monitoring Year	Month	Survey Date	Location	Tide Stage
2002-2003	August	8/24/02	Tidal Wetlands	Low
2002-2003	August	8/24/02	Western Reference	Low
2002-2003	September	9/8/02	Eastern Reference	Low
2002-2003	September	9/8/02	Seasonal Ponds	Low
2002-2003	September	9/8/02	Tidal Wetlands	Low
2002-2003	September	9/8/02	Western Reference	Low
2002-2003	September	9/9/02	Eastern Reference	High
2002-2003	September	9/9/02	Seasonal Ponds	High
2002-2003	September	9/9/02	Tidal Wetlands	High
2002-2003	September	9/9/02	Western Reference	High
2002-2003	September	9/18/02	Eastern Reference	Outgoing
2002-2003	*September*		*Seasonal Ponds*	*Outgoing*
2002-2003	September	9/18/02	Tidal Wetlands	Outgoing
2002-2003	September	9/18/02	Western Reference	Outgoing
2002-2003	September	9/21/02	Eastern Reference	Incoming
2002-2003	September	9/21/02	Seasonal Ponds	Incoming
2002-2003	September	9/21/02	Tidal Wetlands	Incoming
2002-2003	September	9/21/02	Western Reference	Incoming
2002-2003	October	10/5/02	Eastern Reference	High
2002-2003	October	10/5/02	Seasonal Ponds	High
2002-2003	October	10/5/02	Tidal Wetlands	High
2002-2003	October	10/5/02	Western Reference	High
2002-2003	October	10/6/02	Eastern Reference	Outgoing
2002-2003	October	10/6/02	Seasonal Ponds	Outgoing
2002-2003	October	10/6/02	Tidal Wetlands	Outgoing
2002-2003	October	10/6/02	Western Reference	Outgoing
2002-2003	October	10/7/02	Eastern Reference	Low
2002-2003	October	10/7/02	Seasonal Ponds	Low
2002-2003	October	10/7/02	Tidal Wetlands	Low
2002-2003	October	10/7/02	Western Reference	Low
2002-2003	October	10/20/02	Eastern Reference	Incoming
2002-2003	October	10/20/02	Seasonal Ponds	Incoming
2002-2003	October	10/20/02	Tidal Wetlands	Incoming
2002-2003	October	10/20/02	Western Reference	Incoming
2002-2003	November	11/10/02	Eastern Reference	Incoming
2002-2003	November	11/10/02	Seasonal Ponds	Incoming
2002-2003	November	11/10/02	Tidal Wetlands	Incoming
2002-2003	November	11/10/02	Western Reference	Incoming
2002-2003	November	11/16/02	Eastern Reference	Outgoing
2002-2003	November	11/16/02	Seasonal Ponds	Outgoing
2002-2003	November	11/16/02	Tidal Wetlands	Outgoing
2002-2003	November	11/16/02	Western Reference	Outgoing
2002-2003	November	11/18/02	Eastern Reference	High
2002-2003	November	11/18/02	Seasonal Ponds	High
2002-2003	November	11/18/02	Tidal Wetlands	High
2002-2003	November	11/18/02	Western Reference	High
2002-2003	November	11/29/02	Eastern Reference	Low
2002-2003	November	11/29/02	Seasonal Ponds	Low
2002-2003	November	11/29/02	Tidal Wetlands	Low
2002-2003	November	11/29/02	Western Reference	Low
2002-2003	December	12/3/02	Eastern Reference	High

Monitoring Year	Month	Survey Date	Location	Tide Stage
2002-2003	December	12/3/02	Seasonal Ponds	High
2002-2003	December	12/3/02	Tidal Wetlands	High
2002-2003	December	12/3/02	Western Reference	High
2002-2003	December	12/14/02	Eastern Reference	Outgoing
2002-2003	December	12/14/02	Seasonal Ponds	Outgoing
2002-2003	December	12/14/02	Tidal Wetlands	Outgoing
2002-2003	*December*		*Western Reference*	*Outgoing*
2002-2003	December	12/27/02	Eastern Reference	Incoming
2002-2003	December	12/27/02	Seasonal Ponds	Incoming
2002-2003	December	12/27/02	Tidal Wetlands	Incoming
2002-2003	December	12/27/02	Western Reference	Incoming
2002-2003	December	12/29/02	Eastern Reference	Low
2002-2003	December	12/29/02	Seasonal Ponds	Low
2002-2003	December	12/29/02	Tidal Wetlands	Low
2002-2003	December	12/29/02	Western Reference	Low
2002-2003	January	1/14/03	Eastern Reference	Low
2002-2003	January	1/14/03	Seasonal Ponds	Low
2002-2003	January	1/14/03	Tidal Wetlands	Low
2002-2003	January	1/14/03	Western Reference	Low
2002-2003	January	1/18/03	Eastern Reference	High
2002-2003	January	1/18/03	Seasonal Ponds	High
2002-2003	January	1/18/03	Tidal Wetlands	High
2002-2003	January	1/18/03	Western Reference	High
2002-2003	January	1/26/03	Eastern Reference	Incoming
2002-2003	January	1/26/03	Seasonal Ponds	Incoming
2002-2003	January	1/26/03	Tidal Wetlands	Incoming
2002-2003	January	1/26/03	Western Reference	Incoming
2002-2003	January	1/29/03	Eastern Reference	Outgoing
2002-2003	January	1/29/03	Seasonal Ponds	Outgoing
2002-2003	January	1/29/03	Tidal Wetlands	Outgoing
2002-2003	January	1/29/03	Western Reference	Outgoing
2002-2003	February	2/1/03	Eastern Reference	Outgoing
2002-2003	February	2/1/03	Seasonal Ponds	Outgoing
2002-2003	February	2/1/03	Tidal Wetlands	Outgoing
2002-2003	February	2/1/03	Western Reference	Outgoing
2002-2003	February	2/16/03	Eastern Reference	High
2002-2003	February	2/16/03	Seasonal Ponds	High
2002-2003	February	2/16/03	Tidal Wetlands	High
2002-2003	February	2/16/03	Western Reference	High
2002-2003	February	2/24/03	Eastern Reference	Low
2002-2003	February	2/24/03	Seasonal Ponds	Low
2002-2003	February	2/24/03	Tidal Wetlands	Low
2002-2003	February	2/24/03	Western Reference	Low
2002-2003	*February*		*Eastern Reference*	*Incoming*
2002-2003	February	2/25/03	Seasonal Ponds	Incoming
2002-2003	February	2/25/03	Tidal Wetlands	Incoming
2002-2003	February	2/25/03	Western Reference	Incoming
2002-2003	March	3/4/03	Eastern Reference	Outgoing
2002-2003	March	3/4/03	Seasonal Ponds	Outgoing
2002-2003	March	3/4/03	Tidal Wetlands	Outgoing
2002-2003	March	3/4/03	Western Reference	Outgoing

Monitoring Year	Month	Survey Date	Location	Tide Stage
2002-2003	March	3/16/03	Eastern Reference	High
2002-2003	March	3/16/03	Seasonal Ponds	High
2002-2003	March	3/16/03	Tidal Wetlands	High
2002-2003	March	3/16/03	Western Reference	High
2002-2003	March	3/22/03	Eastern Reference	Low
2002-2003	March	3/22/03	Seasonal Ponds	Low
2002-2003	March	3/22/03	Tidal Wetlands	Low
2002-2003	March	3/22/03	Western Reference	Low
2002-2003	March	3/26/03	Eastern Reference	Incoming
2002-2003	March	3/26/03	Seasonal Ponds	Incoming
2002-2003	March	3/26/03	Tidal Wetlands	Incoming
2002-2003	March	3/26/03	Western Reference	Incoming
2002-2003	April	4/12/03	Eastern Reference	Outgoing
2002-2003	April	4/12/03	Seasonal Ponds	Outgoing
2002-2003	April	4/12/03	Tidal Wetlands	Outgoing
2002-2003	April	4/12/03	Western Reference	Outgoing
2002-2003	April	4/13/03	Eastern Reference	High
2002-2003	April	4/13/03	Seasonal Ponds	High
2002-2003	April	4/13/03	Tidal Wetlands	High
2002-2003	April	4/13/03	Western Reference	High
2002-2003	April	4/17/03	Eastern Reference	Incoming
2002-2003	April	4/17/03	Seasonal Ponds	Incoming
2002-2003	April	4/17/03	Tidal Wetlands	Incoming
2002-2003	April	4/17/03	Western Reference	Incoming
2002-2003	April	4/26/03	Eastern Reference	Low
2002-2003	April	4/26/03	Seasonal Ponds	Low
2002-2003	April	4/26/03	Tidal Wetlands	Low
2002-2003	April	4/26/03	Western Reference	Low

Appendix B. Abundance and diversity of bird species. Mean abundance of all bird species recorded per survey at the four monitoring areas, 1998-2003.
An "x" indicates a value of greater than 0 but less than 0.1. Surveys recorded only shorebirds, waterfowl, waterbirds, raptors, and owls.

			Eastern Reference					Western Reference					Seasonal Ponds					Tidal Wetlands				
Common Name	**Genus**	**Species**	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
SHOREBIRDS																						
Black-bellied Plover	*Pluvialis*	*squatarola*	1.7	2.0	2.5	0.8	1.1	0.3	1.9	1.6	1.6	0.7	0.2		0.1		0.1	26.8	37.6	49.9	75.0	64.5
Pacific Golden Plover	*Pluvialis*	*fulva*	0.1																x			
Semipalmated Plover	*Charadrius*	*semipalmatus*		x		0.1				x					0.2	1.1	1.5	0.9	10.1	4.4	0.7	0.3
Killdeer	*Charadrius*	*vociferus*		0.2		0.1	0.3	x	0.1	0.2		0.2	0.7	0.8	2.0	2.5	4.7	2.5	8.7	5.5	4.5	5.9
American Avocet	*Recurvirostra*	*americana*	13.9	10.7	17.5	2.1	4.5	1.7	7.3	2.7	1.2	3.8	12.0	4.2	19.2	54.5	27.7	23.8	6.4	12.2	17.9	22.6
Black-necked Stilt	*Himantopus*	*mexicanus*	17.9	9.7	9.6	5.1	4.2	3.0	7.3	6.9	5.2	4.2	7.3	0.5	2.4	9.0	8.0	2.1	16.8	17.1	8.1	24.9
Wilson's Snipe	*Gallinago*	*delicata*																			x	
Willet	*Catoptrophorus*	*semipalmatus*	87.0	41.2	54.2	106.7	55.3	68.4	86.2	198.0	174.8	115.5	0.2	0.1		1.9	2.1	16.8	83.4	49.7	32.1	81.8
Greater Yellowlegs	*Tringa*	*melanoleuca*											0.8					0.1	0.1			
Yellowlegs Sp.	*Tringa*		3.6	1.1	1.5	1.2	0.4	0.6	0.3	0.7	0.1	0.2	0.4	0.1		5.8	2.5	3.7	9.0	11.3	13.5	11.3
Whimbrel	*Numenius*	*phaeopus*	0.3	0.1	0.2	x	0.1			0.2		0.1				0.2	x	0.9	0.6	0.5	1.0	0.9
Long-billed Curlew	*Numenius*	*americanus*	0.6	1.3	1.9		0.1	0.2	0.5	1.4	x			0.4		1.7	0.6	5.0	4.9	5.4	6.6	8.6
Marbled Godwit	*Limosa*	*fedoa*	33.9	20.3	17.1	43.9	26.6	30.3	44.2	71.2	115.5	68.5				0.8	0.1	7.7	94.2	68.7	33.9	125.8
Ruddy Turnstone	*Arenaria*	*interpres*	0.1			x	0.1			0.1	x								x	x		
Black Turnstone	*Arenaria*	*melanocephala*	1.3	0.9	4.3	1.0	1.2	1.0	0.8	3.4	0.3	0.3					x	0.4	1.3	1.4	1.7	0.2
Red Knot	*Calidris*	*canutus*	x									0.3										0.1
Sanderling	*Calidris*	*alba*																0.6				
Dunlin	*Calidris*	*alpina*	20.2	9.6	3.3	0.8	0.5	1.4	3.9	2.9	1.3	6.5	7.8		0.1	0.4	23.1	62.9	79.9	63.5	42.3	60.1
Western Sandpiper	*Calidris*	*mauri*	8.8		0.1		0.2				3.3	1.5	1.8			0.4	1.5	6.3	17.1		3.5	0.6
Least Sandpiper	*Calidris*	*minutilla*	1.2		0.6		0.1	1.1		0.1	1.0	0.3	1.2	0.8			0.9	6.6	34.0		4.1	4.2
Western/Least Sandpiper	*Calidris*		53.8	23.4	32.7	18.4	3.3	18.6	46.2	30.5	9.7	20.7	4.4	0.8	15.8	36.6	83.0	105.7	476.8	180.3	162.1	177.9
Pectoral Sandpiper	*Calidris*	*melanotos*							x													
Dowitcher Sp.	*Limnodromus*		43.7	17.5	23.3	50.3	30.2	23.7	13.9	1.7	30.5	9.5	2.3	0.8	0.6	1.3	8.0	10.2	58.5	37.2	21.7	26.9
Red Phalarope	*Phalaropus*	*fulicaria*																	x			
large shorebird			46.0	11.7	12.2	3.3	0.1		7.9	6.4	1.0	2.9			1.7	0.9		0.9	0.6	0.4	5.6	22.3
small shorebird			3.5	55.9	18.3	0.2	13.8	30.4	20.3	18.5	15.5	2.9	61.9		16.1	0.2	2.9	246.3	66.1	112.3	55.0	65.4
Mean Shorebirds			**337.6**	**205.6**	**199.3**	**234.0**	**142.1**	**180.7**	**240.8**	**346.5**	**361.0**	**238.1**	**101.0**	**8.5**	**58.2**	**117.3**	**166.7**	**530.2**	**1006.1**	**619.8**	**489.3**	**704.3**
No. Shorebird Species			**16**	**14**	**13**	**14**	**15**	**13**	**13**	**15**	**13**	**14**	**10**	**8**	**8**	**12**	**15**	**16**	**18**	**15**	**16**	**16**
WATERFOWL																						
Canada Goose	*Branta*	*canadensis*	5.1	1.5	1.8	3.3	1.7	3.5	3.6	9.7	8.3	18.9	1.2	3.5	13.5	4.1	18.1	6.8	3.3	10.2	1.8	4.2
Greater White-fronted Goose	*Anser*	*albifrons*					0.3					0.2					0.3					
Snow Goose	*Chen*	*caerulescens*										x					x	0.1				
Mallard	*Anas*	*platyrhynchos*	12.3	13.5	8.3	7.1	6.7	5.6	4.8	5.8	3.1	1.9	1.4	2.2	3.3	4.1	5.5	2.0	0.7	2.1	21.6	23.3
Gadwall	*Anas*	*strepera*	0.9	0.5	0.1	0.3	0.1			0.8		0.2	2.9	2.8	2.1	4.7	5.5		0.1	0.2	0.5	
Green-winged Teal	*Anas*	*crecca*	5.7	3.7	5.3	2.9	2.6	0.8	0.9	2.2	0.3	0.1	0.3			1.9	3.0			0.2	0.3	0.2
Blue-winged Teal	*Anas*	*discors*	0.1	1.6	0.1				0.2		x											0.2
American Wigeon	*Anas*	*americana*	66.8	39.2	30.1	31.2	16.3		16.3	1.9	15.1	7.1	64.4	38.0	23.4	42.4	61.4	0.8	1.8	4.2	26.6	36.3
Eurasian Wigeon	*Anas*	*penelope*	x	0.1			x	6.0	x				0.2									
Northern Pintail	*Anas*	*acuta*	3.4	2.9	3.0	3.5	3.7	0.5	2.3	0.4	x	0.8	0.2	1.3	1.2	2.4	7.8		0.4	1.4	8.3	8.2
Northern Shoveler	*Anas*	*clypeata*	9.0	3.2	1.2	3.7	2.4	0.2	0.3	0.8	0.2	2.7	33.6	1.3	5.7	11.2	14.9	3.2	0.5	0.1	x	0.7
Cinnamon Teal	*Anas*	*cyanoptera*	3.8	2.0	0.5	0.3	0.1	0.5	0.1	0.1			0.1			0.1						
Canvasback	*Aythya*	*valisineria*	3.5	2.8	3.3	8.8	6.0	1.8	0.4	0.9	0.1	0.8					x					
Redhead	*Aythya*	*americana*			x																	
Greater Scaup	*Aythya*	*marila*	14.8					0.5						0.1								
Lesser Scaup	*Aythya*	*affinis*		x																		
Scaup Sp.	*Aythya*		292.5	125.5	279.5	76.8	111.0	10.3	8.8	16.5	44.8	27.3		0.1		2.7	0.1	x	0.2		5.7	5.4
Surf Scoter	*Melanitta*	*perspicillata*	0.1	2.2	0.6	12.0	6.8	x	0.1		1.3	2.0							0.3		0.1	
Barrow's Goldeneye	*Bucephala*	*islandica*	0.1	0.3	0.1	0.2	0.1	x	0.1	0.2	0.1	x									0.1	

			Eastern Reference					Western Reference					Seasonal Ponds					Tidal Wetlands				
Common Name	**Genus**	**Species**	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Common Goldeneye	*Bucephala*	*clangula*	2.8	1.2	6.0	1.2	1.0	0.3	0.3	2.1	1.0	0.6	0.2	0.2		0.3	0.3	x	0.1		0.5	0.1
Bufflehead	*Bucephala*	*albeola*	7.4	4.6	3.0	4.3	2.5	5.5	4.3	2.7	1.6	4.2	1.4	1.3	2.1	3.6	4.6	0.7	1.0	0.3	0.5	1.4
Ruddy Duck	*Oxyura*	*jamaicensis*	43.5	59.5	68.3	41.4	24.8	5.4	1.1	2.5	4.9	5.3	0.1	0.2		0.3	0.9				x	
Duck Sp.			28.7	117.3	16.3	1.0	0.5	1.0	10.1	3.7	0.5	0.2	0.1	3.0	0.2	x	x	1.7	0.1	0.4	0.1	0.4
Mean Waterfowl			**500.5**	**381.6**	**427.5**	**198.0**	**186.6**	**41.9**	**53.7**	**50.3**	**81.3**	**72.3**	**106.1**	**54.0**	**51.5**	**77.8**	**122.4**	**15.3**	**8.5**	**19.1**	**66.1**	**80.4**
No. Waterfowl Species			**17**	**17**	**17**	**15**	**17**	**14**	**16**	**14**	**14**	**16**	**12**	**10**	**7**	**12**	**14**	**8**	**10**	**8**	**13**	**10**
GULLS AND TERNS																						
Heermann's Gull	*Larus*	*heermanni*									0.1		0.1					0.1	0.1			
Bonaparte's Gull	*Larus*	*philadelphia*		x					x				0.4						0.1			
Ring-billed Gull	*Larus*	*delawarensis*	1.7	6.3	1.1	1.6	1.3	0.6	3.8	1.4	2.4	0.7	23.4	5.2	9.1	9.8	6.5	11.6	5.1	1.0	4.5	3.5
Mew Gull	*Larus*	*canus*								x			1.0		1.0			0.1				
California Gull	*Larus*	*californicus*	0.1	0.1	0.1	0.7		1.2	0.2	0.1	0.3	0.2	2.1	0.4	1.4		1.4	4.4	1.7		0.4	1.4
Herring Gull	*Larus*	*argentatus*	x			x				2.3			1.6					0.1	x	0.6		
Western Gull	*Larus*	*occidentalis*	0.7	5.0	3.8	2.3	3.9	2.3	3.6	2.7	7.3	1.4	15.2	6.8	11.5	18.4	3.9	7.5	12.0	0.4	1.2	1.4
Glaucous-winged Gull	*Larus*	*glaucescens*	0.3	0.3	0.4	0.2	x	1.2	0.1	x	0.1	0.1		0.1	0.2	x	0.1	0.2	3.2	0.1	x	
Gull Sp.	*Larus*		11.8	37.6	13.4	5.7	13.3	3.1	12.3	30.5	18.8	28.9	63.3	14.0	15.2	42.5	58.1	74.0	28.9	30.8	20.9	19.6
Caspian Tern	*Sterna*	*caspia*		0.1		0.3			0.1	0.1		0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.4	0.2	0.4	0.9
Forster's Tern	*Sterna*	*forsteri*	0.6	0.8	1.9	0.9	1.9	0.6	1.4	1.6	0.9	0.8		x		0.1	0.1	0.3	0.3	1.0	1.1	1.9
Least Tern	*Sterna*	*antillarum*		x							0.1	x										
Tern sp.				0.1					x	0.1								0.1	0.1		0.3	
Mean Gulls and Terns			**15.2**	**50.3**	**20.7**	**11.7**	**20.4**	**9.0**	**21.5**	**38.8**	**30.0**	**32.2**	**107.3**	**26.6**	**38.6**	**70.9**	**70.3**	**98.5**	**51.9**	**34.1**	**28.8**	**28.7**
No. Gull and Tern Species			**6**	**8**	**5**	**7**	**4**	**5**	**7**	**8**	**7**	**7**	**8**	**6**	**6**	**5**	**6**	**9**	**9**	**6**	**6**	**5**
OTHER WATERBIRDS																						
Loons																						
Common Loon	*Gavia*	*immer*	x	0.1				0.1														
Pacific Loon	*Gavia*	*pacifica*		0.1					x													
Red-throated Loon	*Gavia*	*stellata*		x				0.1														
Grebes																						
Western Grebe	*Aechmophorus*	*occidentalis*	4.6	5.5	4.8	6.4	3.7	4.5	7.6	0.4	1.7	3.7							x		0.1	
Clark's Grebe	*Aechmophorus*	*clarkii*	0.8	1.1	0.7	0.6	2.6	0.5	0.4	0.2	0.3	0.6										
Horned Grebe	*Podiceps*	*auritus*	2.3	0.9	0.7	0.7	1.3	2.5	2.5	0.1	1.1	0.7				x	x					0.1
Eared Grebe	*Podiceps*	*nigricollis*	1.5	1.1	1.8	1.2	1.5	0.8	0.7	0.9	0.8	1.0				0.1	x					0.1
Pied-billed Grebe	*Podilymbus*	*podiceps*	1.0	1.4	2.1	1.7	2.2	0.2	0.4	1.3	0.6	0.4						0.3	0.1		0.1	
Pelicans and Cormorants																						
American White Pelican	*Pelecanus*	*erythrorhynchos*					x					0.3										
Brown Pelican	*Pelecanus*	*occidentalis*	0.3	0.1	2.4	0.3	0.5	0.2	0.2	1.9	0.3	0.2									0.1	x
Double-crested Cormorant	*Phalacrocorax*	*auritus*	1.0	7.0	3.1	4.9	5.6	0.8	0.4	6.0	2.4	6.8			0.1		x	0.7	0.1	2.7		0.9
Herons and Egrets																						
Black-crowned Night-heron	*Nycticorax*	*nycticorax*		x	0.1	0.1	0.5		0.2	x	x							x				
Snowy Egret	*Egretta*	*thula*	2.1	2.3	2.1	1.6	1.4	1.0	1.4	3.8	3.1	4.2				0.1	x	4.2	7.3	10.3	11.4	12.5
Great Egret	*Ardea*	*alba*	x	0.5	0.9	0.5	0.4	0.2	0.6	1.3	2.0	0.9	0.1	x		0.1		0.4	1.0	1.4	0.7	0.5
Great Blue Heron	*Ardea*	*herodias*	x	0.5	0.3	0.4	0.2	0.2	0.2	0.3	0.3	0.2					0.1	0.2				0.1
Green Heron	*Butorides*	*vivescens*																				x
Rails and Coots																						
Clapper Rail	*Rallus*	*longirostris*	0.7	1.4	0.4	0.9	1.4	0.6	0.6	0.3	0.4	0.8										
Virginia Rail	*Rallus*	*limicola*		0.1		x	x					x										
Sora	*Porzana*	*carolina*		x	x		x															
American Coot	*Fulica*	*americana*	66.4	49.6	40.1	20.4	12.7	26.0	29.2	22.9	11.8	4.7	x	x		6.0	8.0	6.6	10.2		11.9	4.4
Alcids																						
Marbled Murrelet	*Brachyramphus*	*marmoratus*										x										
Kingfisher																						
Belted Kingfisher	*Ceryle*	*alcyon*	x			x	x	x		0.1								x	0.1			0.1

			Eastern Reference					Western Reference					Seasonal Ponds					Tidal Wetlands				
Common Name	**Genus**	**Species**	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Mean Other Waterbirds			**80.7**	**71.7**	**59.5**	**39.7**	**34.0**	**37.7**	**44.4**	**39.5**	**13.0**	**24.5**	**0.1**	**0.0**	**0.1**	**6.3**	**8.1**	**12.4**	**18.8**	**14.4**	**24.3**	**18.7**
No. Waterbird Species			**14**	**18**	**14**	**15**	**17**	**15**	**14**	**14**	**13**	**15**	**2**	**2**	**1**	**5**	**6**	**8**	**7**	**3**	**6**	**10**
RAPTORS & OWLS																						
Burrowing Owl	*Athene*	*cunicularia*												0.2	0.6	1.2	0.3				x	
Turkey Vulture	*Cathartes*	*aura*	x	0.2	0.4	0.4	x	0.1	0.2	0.3	0.1	0.1	x	0.5	0.4	0.7	0.2	0.2	1.1	1.1	1.2	0.3
Golden Eagle	*Aquila*	*chrysaetos*												x					x			
Osprey	*Pandion*	*haliaetus*	x						x		x							x				
Northern Harrier	*Circus*	*cyaneus*	x	0.3	0.1	0.1	0.1	0.2	0.1	0.1	0.1	x	x	0.2		0.2	0.1	x	0.3	0.1	0.1	0.3
White-tailed Kite	*Elanus*	*leucurus*												x		x					x	
Red-tailed Hawk	*Buteo*	*jamaicensis*	0.1	x	0.1	0.1	x	0.1	0.1	0.2	0.1	0.1		0.3	0.1	0.1	x	0.1	0.4	0.5	0.1	0.2
Red-shouldered Hawk	*Buteo*	*lineatus*									x											
Sharp-shinned Hawk	*Accipiter*	*striatus*					x															
Cooper's Hawk	*Accipiter*	*cooperi*										x										
Merlin	*Falco*	*columbarius*							x												x	
American Kestrel	*Falco*	*sparverius*		x									0.1	0.1			0.1			x	0.1	
Peregrine Falcon	*Falco*	*peregrinus*	x											x	0.1			x	x	0.1	0.8	0.1
Mean Raptors			**0.1**	**0.5**	**0.6**	**0.6**	**0.1**	**0.4**	**0.4**	**0.6**	**0.3**	**0.2**	**0.1**	**1.3**	**1.2**	**2.2**	**0.7**	**0.3**	**1.8**	**1.8**	**2.3**	**0.9**
No. Raptor Species			**5**	**4**	**3**	**3**	**4**	**3**	**5**	**3**	**5**	**4**	**3**	**8**	**4**	**5**	**5**	**5**	**5**	**4**	**8**	**4**
Mean No. all Birds			**934.1**	**709.7**	**707.6**	**484.0**	**383.2**	**269.7**	**360.8**	**475.7**	**485.6**	**367.3**	**314.6**	**90.4**	**149.6**	**274.5**	**368.2**	**656.7**	**1087.1**	**689.2**	**610.8**	**833.0**
TOTAL NO. SPECIES			**58**	**61**	**52**	**54**	**57**	**50**	**55**	**54**	**52**	**56**	**35**	**34**	**26**	**39**	**46**	**46**	**49**	**36**	**49**	**45**

Appendix C – Save San Francisco Bay Association Volunteer Activities

Save San Francisco Bay Association
Community-Based Restoration Program
Martin Luther King, Jr. Regional Shoreline
Native Plant Nursery and Restoration Project

Save The Bay contact:
Marilyn Latta, Habitat Restoration Manager
452-9261 x110 or mlatta@savesfbay.org

Project Overview
Save The Bay was one of the original groups involved in the 1998 lawsuit resulting in the restoration of the 72 acre tidal marsh at the Martin Luther King, Jr. Regional Shoreline. Since that time, Save The Bay has aligned our advocacy and educational goals through building a community stewardship program to involve both students and adults in the wetland restoration project, both to raise public awareness and involve community members in the restoration process. Starting in 2000, Save The Bay began a partnership with East Bay Regional Park District to identify and plan activities that would be beneficial to the restoration project that layperson volunteers could do. Activities such as weed removal, native seed collection, plant propagation, and native plantings are easy to learn, educational, and connect participants to the process of wetland habitat restoration in the Bay Area.

Volunteers Have Made A Difference
- Between July 2000 and May 2004, **6,746 students** and **2,454 adults** have volunteered their time to assist with the restoration of the Martin Luther King, Jr. Regional Shoreline and the 72 acre restoration marsh.
- In total, more than **9,200 volunteers** have contributed over **32,200 hours** of their time!
- Removal of more than **25,000 pounds of non-native invasive weeds** from the restoration marsh and along Damon Slough.
- Establishment of a **Wetlands Native Plant Nursery** on-site in 2002, a partnership between East Bay Regional Park District and Save The Bay.
- More than **20,000 native wetland plants** have been been grown from seed and planted.
- More than **15,000 pounds of trash and recyclables** have been removed from the site.

Objectives
- Involve local high school students and community members in bay education and habitat restoration efforts along the Martin Luther King, Jr. Regional Shoreline and Restoration Marsh.
- Assist in the restoration of wetland and shoreline transition habitat, through non-native plant removal, native plant propagation and planting, and shoreline clean-ups.

- Link these volunteers with the wetland restoration project currently being undertaken at the MLK, Jr. Regional Shoreline by various agencies and nonprofits, in order to increase the public's knowledge of restoration work in the Bay Area. Principal partner agencies and non-profits include: East Bay Regional Park District, California Coastal Conservancy, the National Partnership between Restore America's Estuaries and NOAA Fisheries Community-based Restoration Program, Friends of the San Francisco Estuary, Golden Gate Audubon Society, and the MLK Freedom Center.
- Propagate native wetland plants with volunteers in the Wetlands Native Plant Nursery located at Garretson Point. Plants are grown from seed collected on site by volunteers.
- Evaluate the effects of the restoration projects, by monitoring non-native plant removal and planting success with students and community members.

Methods
Save The Bay works with community groups, high school students and teachers, businesses, watershed groups, and land management agencies to restore wetland habitat at the Martin Luther King, Jr. Regional Shoreline. Save The Bay works in collaboration with East Bay Regional Park District to develop and implement community-based restoration activities that are appropriate for local students and volunteers. The Martin Luther King Jr. Shoreline encompasses San Leandro Bay, Damon Slough and Marsh, Arrowhead Marsh, and the MLK restoration marsh. There are five creeks that flow into San Leandro Bay at this site, including: San Leandro, Elmhurst, Stonehurst, Arroyo Viejo, and Lion Creeks. Also, Sausal, Peralta, Courtland, and Seminary Creeks all enter the Bay just north of the MLK, Jr. Shoreline.

Save The Bay's restoration activities include:

- restoration and monitoring planning with partners
- native plant propagation and planting
- non-native plant removal
- shoreline and creekbank enhancements
- shoreline and creek clean-ups
- environmental education and outreach

Save The Bay's goals for these projects are to:

- involve community groups and schools in restoration and monitoring,
- enhance wetland, estuarine, and riparian habitat around the Bay, and
- leverage funding through partnerships, to create an effective program of community involvement that fits with the restoration and monitoring plan for the MLK, Jr. Shoreline

The main components of the project at the MLK Shoreline are:

- removing non-native invasive species, specifically *Lepidium latifolium*, *Foeniculum vulgare, and Carpobrotus edulis* from the marshes;
- native plant propagation from seeds collected locally, primarily *Grindelia*, *Triglochin, Jaumea, Frankenia, Distichlis, Limonium,* and also other riparian and

salt marsh species;
- growing these natives in our on-site wetlands native plant nursery with volunteers;
- winter outplantings along the edges of the Restoration Marsh and Damon Slough, and in the adjacent upland;
- cleaning up the creeks, shoreline and the trails.

2003-2004 Project Accomplishments:
- Save The Bay led 158 restoration field programs between 9/1/03-7/20/04, for a total of 2,362 students and 701 adults. A total of 3,063 community volunteers contributed over 10,071 total hours towards restoration and stewardship activities at the sites.
- Volunteers removed an estimated 10,000 pounds of non-natives from the sites.
- Volunteers removed over 3,000 pounds of trash from the sites.
- Volunteers planted over 8,000 native plants over the winter rainy season. Species include *Grindelia stricta, Triglochin maritima, Frankenia salina, Distichlis spicata, Limonium californicum.*
- We propagated over 10,000 native wetland seedlings in our first year of the new Wetland Native Plant Nursery. Due to the short rainy season, we were only able to plant out 8,500 of these plants, and the rest will be potted up and planted in Winter 04-05.
- Continued development of our Site Monitoring Program to monitor the success of our non-native removal and native plantings. All restoration site areas have been marked into plots, where we involve volunteers in photomonioring and vegetation surveys to track the success of our work on native plant communities in the wetlands and transition zone.

Background
Save The Bay coordinates with East Bay Regional Park District to plan activities for community participation on the shoreline. The MLK Shoreline surrounds the southern end of San Leandro Bay, which is the end point for many of the creeks in Oakland and San Leandro. Save The Bay was involved in the original litigation against the Port of Oakland, successfully requiring wetland restoration work at the Shoreline. We have also conducted on-the-water field trip programs for middle and high school students at the Shoreline, as part of our Canoes in Sloughs program.

The Canoes in Sloughs Watershed Education Program (CIS) has been leading on-the-water field trips for 6^{th}-12^{th} graders along the MLK Jr. Shoreline and Arrowhead Marsh since 1998. Arrowhead Marsh has also been an excellent site for both one-day and week-long teacher workshops. Save The Bay has also collaborated with other local educational and non-profit groups to increase awareness about the MLK Jr. Shoreline and wetlands.

Save The Bay developed our Community-Based Restoration Program in Fall 2000, with our first project site at the MLK, Jr. Regional Shoreline. Community and school participation demonstrates strong support for the project; we have worked with over

9,000 volunteers total at this site in just under four years. Save The Bay's goal is to develop and implement citizen involvement as part of the restoration and monitoring plan for the site, in collaboration with the East Bay Regional Park District, Golden Gate Audubon Society, Friends of the Estuary, and local schools and community groups.

Strategies and Activities

Save The Bay offers the following types of programs:

- Volunteer training workshops for student and community volunteers on Saturdays
- School group restoration programs
- Community and student volunteer workdays on Saturdays
- Weekday drop-in Native Plant Nursery programs

Wetland Native Plant Nursery – Garretson Point

In December 2002, Save The Bay and East Bay Regional Park District established a native plant nursery area at the Martin Luther King, Jr. Regional Shoreline. We have been collecting seed and propagating native plants at local nurseries over the past two years, and now we can grow native plants on site with the help of volunteers. This is ideal for us because it involves the volunteers in all steps of the restoration process, from non-native removal to seed collection to plant propagation and outplanting. This allows up to further reach our educational goals for the restoration program as a whole. We host nursery drop-in volunteer days on alternate Fridays from 1-3pm, and activities include seed collection, plant propagation and transplanting, watering, and other maintenance associated with growing native wetland plants.

Principal Partner Agency: EBRPD

Our working partnership with East Bay Regional Park District is critical to the success of the project. The Park Supervisor and staff have participated in planning meetings, site preparation, lending tools, scheduling groups, and identifying specific areas in the park for native plant restoration. Save The Bay will continue to work closely with Park staff to schedule and plan projects so that the restoration activities meet the goals of the Park and are scheduled in an organized way with other groups at the site.

Schedule

Fall 2004

- Schedule community groups and schools, conduct weekday and Saturday field programs.
- Develop restoration plans for the sites in collaboration with EBRPD staff.
- Develop monitoring protocols for the sites with environmental consultant.
- Continue seed collection from sites.
- Continue plant propagation.

September - October, 2004

- Conduct restoration project days (weeding, seed collection, and clean-ups) with high schools and community groups.
- Continue monitoring sites.

- Continue seed collection and plant propagation.

November 2004 - March 2005
- Conduct restoration project days (weeding, native plantings, and clean-ups) with high schools and community groups.
- Continue monitoring sites.
- Continue plant propagation.

March – May, 2005
- Conduct restoration project days (weeding and clean-ups).
- Celebrate Earth Day, National Wetlands Month.

June 2005
- Host Volunteer Celebration Event and STB Picnic.
- Evaluate sites and develop future plans for sites.

Benefits to Living Marine Resources
By working to restore wetlands, we will provide a variety of benefits to marine species, including increased food supply, nesting and breeding habitat, and improved water quality. Estuarine, wetland, and riparian restoration projects will improve water quality and habitat for marine resources. The San Leandro Bay and Creek provide habitat for an abundance of living marine resources including steelhead trout, bat rays, leopard sharks, sturgeon, shrimp, clams, and mussels, along with an abundance of shorebirds and waterfowl. We will choose other sites that currently do support or potentially could support steelhead trout. At these sites, we will conduct restoration projects that enhance the survival of resident and migratory species in urban settings.

Community Participation/Education Outreach
We conduct all restoration planning, restoration work, and monitoring in conjunction with community groups and local high schools. Weeding, plant propagation, plantings, and clean-ups will be undertaken by these groups with our assistance and planning.

We host workshops to educate teachers, students, and community members about the ecology of San Francisco Bay, and to train them in restoration and monitoring techniques. Workshops prepare adults and students to conduct restoration work in our restoration sites around the Bay.

We also work with local schools to bring Bay education into the classroom, providing teacher workshops and classroom outreach. All participating schools will receive our San Francisco Bay Watershed Curriculum Guide with classroom activity and restoration project ideas. Additionally, the schools involved will be able to network with each other, sharing information and working together to conduct the project.

Monitoring and Maintenance Plans
Save The Bay works closely with other local agencies and organizations to monitor and maintain the sites. We are working with a consultant at Wetlands Research Associates to

develop a Monitoring Program to monitor the success of our efforts at the site. We will use the Environmental Protection Agency's (EPA) Volunteer Training protocols and policies to train volunteers, and will collect data based upon their protocols. Since the project monitoring required by the original lawsuit is ending in 2004, we see an opportunity to use our volunteers to continue to collect this data.

Appendix D – Golden Gate Audubon Society Avian Monitoring Volunteers List

2002-2003

Bob Battagin
Betty Berenson
Kathryn Blake
Kay Bloom
Andree Breaux
Howard Brownson
Virginia Choiniere
Timothy Cleere
Joan Collignon
Kristin Doner
Judith Dunham
Arthur Feinstein
Sue Gallagher
Brad Goya
Barbara Haley
Anne Hoff
Cathy Hubbard
Richard Kaufmann
Carolyn Kolka
Scott Lambert
Jill Lawrence
Melanie Lutz
Mona Mena
Collin Murphy
Marilyn Nasatir
Charlotte Nolan
Carol Oda
Kristin Ohlson
Nancy Page
Courtenay Peddle
Lori Poulson
Douglas Pryne
Mike Richter
Phila Witherell Rogers
Ruth Sayre
Elizabeth Sojourner
Carol Thorp
Ed Walker
Joanne Wallin
Herta Weinstein
Marian Whitehead
Rhea Williamson
Sophia Wong

2001-2002

Bob Battagin
Betty Berenson
Kathryn Blake
Kay Bloom
Andree Breaux
Howard Brownson
Virginia Choiniere
Timothy Cleere
Joan Collignon
Kristin Doner
Judith Dunham
Arthur Feinstein
Sue Gallagher
Barbara Haley
Anne Hoff
Cathy Hubbard
Richard Kaufmann
Carolyn Kolka
Scott Lambert
Jill Lawrence
Melanie Lutz
Mona Mena
Collin Murphy
Marilyn Nasatir
Charlotte Nolan
Carol Oda
Kristin Ohlson
Nancy Page
Courtenay Peddle
Lori Poulson
Mike Richter
Phila Witherell Rogers
Ruth Sayre
Mary Schaefer
Elizabeth Sojourner
Inge Svoboda
Carol Thorp
Ed Walker
Joanne Wallin
Herta Weinstein
Marian Whitehead
Rhea Williamson

2000-2001

Bob Battagin
Betty Berenson
Kathryn Blake
Kay Bloom
Andree Breaux
Howard Brownson
Virginia Choiniere
Timothy Cleere
Joan Collignon
Kristin Doner
Judith Dunham
Sue Gallagher
Barbara Haley
Susan Hampton
Anne Hoff
Cathy Hubbard
Richard Kaufmann
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Lori Poulson
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Phila Witherell Rogers
Ruth Sayre
Mary Schaefer
Elizabeth Sojourner
Inge Svoboda
Carol Thorp
Ed Walker
Joanne Wallin
Herta Weinstein
Marian Whitehead
Rhea Williamson

1999-2000

Bob Battagin
Kathryn Blake
Kay Bloom
Andree Breaux
Howard Brownson
Timothy Cleere
Joan Collignon
Kristin Doner
Judith Dunham
Sue Gallagher
Peter Goldman
Barbara Haley
Susan Hampton
Cathy Hubbard
Evelyn Kennedy
Caroline Kim
Carolyn Kolka
Scott Lambert
Jill Lawrence
Melanie Lutz
Mona Mena
Collin Murphy
Marilyn Nasatir
Charlotte Nolan
Nancy Page
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Steve Walsh