Monitoring Report
Fall 2001 to Fall 2002, Project Year 4
Martin Luther King, Jr. Regional Shoreline
Wetlands Project
Oakland, California

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Prepared for

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WETLANDS AND WATER RESOURCES

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TABLE OF CONTENTS

Tables

Figures

Appendices

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. A complete site description is presented in the Six-Month Monitoring Report (LFR 1999b).

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

1. **Monitoring and Maintenance Plan** (the “MMP”) presents the Project objectives, performance criteria, and monitoring protocols developed to assess the progress of the Project (LFR 1999a).
2. **Six-Month Monitoring Report** presents the results of the first six months of monitoring, encompassing the period from project initiation 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.
3. **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 both 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.
4. **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). This report is contained in an appendix of the current report.
5. **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.
6. **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). This report is contained in an appendix of the current report.
7. **Year 3 (2000-2001) Monitoring Report** presents results of the third monitoring year (WWR 2002). 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.

8. **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). This report is contained in an appendix of the current report.
9. **Macroinvertebrate Study Year 2000** (Jones and Stokes 2000) presents results of benthic macroinvertebrate population monitoring performed by Jones and Stokes in May 2000. This report is contained in an appendix of the current report.
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. This data is contained in an appendix of the current report.

Current Report for Fall 2001 to Fall 2002 Monitoring. This report presents the results of monitoring conducted from Fall 2001 to Fall 2002, representing Project Year 4. Table 1 shows planned and actual field schedules for the 2001-2002 monitoring year. This report divides WWR monitoring activities into two broad categories: hydrogeomorphic monitoring (Section 2) and biological monitoring (Section 3). Within each of these two categories, this report presents monitoring results for the tidal wetlands, seasonal ponds, and upland areas. Section 4 includes a list of monthly EBRPD maintenance activities performed throughout the monitoring year. Section 5 provides an evaluation of project performance in the aforementioned areas (i.e., hydrogeomorphic, biologic, and maintenance). Performance evaluation is based on performance criteria and stressor indicators established in the Monitoring and Maintenance Plan (LFR 1999a). Section 6 discusses issues that arose during the current monitoring period.

2.0 Hydrogeomorphic Monitoring

The monitoring plan (LFR 1999a) included seven hydrogeomorphic monitoring activities (Table 1). This section discusses all seven monitoring activities and is organized in the following manner:

- Section 2.1, Channel cross sectional morphology
- Section 2.2, Sediment accretion
- Section 2.3, Seasonal pond depth and acreage
- Section 2.4, Tidal inundation
- Section 2.5, Channel velocity, turbidity, and water quality
- Section 2.6, Aerial photography
- Section 2.7, Channel planform meander

2.1 Channel Cross Sectional Morphology

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. 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).

2.1.1 Methods

To assess changes in channel cross section morphology, the MMP calls for annual topographic surveys at established cross sections. Cross sections include the channel and approximately 10 meters of the adjacent marsh plain. Cross section endpoints on the marsh plain are PVC markers previously placed and more recently painted red so that cross section locations could be reoccupied. During annual field surveys, we use optical or laser total station instruments to record distance along cross section and relative elevation. We then survey each cross section into at least one established permanent benchmark located near the breach at the north end of the site; the Port of Oakland provided these benchmarks and data are included in Appendix A.

For the current monitoring period, we conducted these surveys on 1 August 2002. During the previous monitoring year (2000-2001), we surveyed on July 12 and August 24, 2001. During the 1999-2000 monitoring year we conducted surveys on September 27, 2000 and January 3, 2001. During the first year of monitoring (1998-1999) Levine-Fricke-Recon and Lenington Ecological Services conducted surveys on July 18, 1998 and January 23 and 29, 1999.

2.1.2 Results and Discussion

Figure 2 shows the cross section locations. Figure 3 shows the two first-order channel cross sections, Figure 4 shows the two second-order channel cross sections, and Figure 5 shows the third-order cross section. These figures plot previous cross section survey data alongside current data. Appendix B provides the field surveying data since monitoring inception, some collected by WWR and some by previous contractors. Pre-WWR data, from LFR (1999a), have not been verified; horizontal and vertical controls were not clearly evident for all pre-WWR cross sections and are so 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. In this view, the channel left bank on an ebb tide is shown to the left and the channel right bank is shown to the right. These plots reverse that presented in LFR 1999b. All cross sections plot data with matching horizontal and vertical scales so that relative channel sizes are visually evident between cross sections. These plots adjust that presented in LFR 1999b.

The 2002 topographic data for all five monitored channel cross sections indicate little to no significant change occurred in channel size, morphology, or position within the past monitoring year. See Figures 3, 4, and 5. Cross section XS-2E shows the greatest change, with top width widening to about 20 ft from 17 to 18 ft in 2001 and depth increased roughly 0.1-0.2 ft. These changes could be equally due to actual channel enlargement or small variations in exact cross section position in the channel between years.

These minor changes in morphology during the current monitoring period suggest that the channel network may have approached a quasi-equilibrium, at least temporarily, with the site’s tidal prism. If in quasi-equilibrium, future shifts could occur as accretion and further vegetation colonization slowly diminish the tidal prism. Alternatively, channel changes may be at slow rates undetectable by the monitoring method.

2.2 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). Those estimates were accomplished during design by collecting a water sample from near the project site at slack high tide and measuring suspended solids concentration (SSC) of that sample. The design incorporated two predicted sedimentation periods (not rates). The first sedimentation period applied to higher-elevation areas ("high marsh") and predicted 100 years to reach local mean higher high water (MHHW) elevations assuming a starting elevation of 0.57 ft (0.17 m) below local MHHW. That predicted sedimentation period corresponds to an average annual sedimentation rate of 0.006 ft/yr or 0.002 m/yr. The second sedimentation period applied to lower-elevation areas ("low marsh") and predicted 10 years to reach 1 ft below local MHHW elevations assuming a starting elevation of 1.5 ft (0.46 m) below local MHHW. That predicted sedimentation period corresponds to an average annual sedimentation rate of 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.

2.2.1 Methods

In previous years, the monitoring plan relied upon fixed sediment pins measured annually to document sedimentation rates at the site. Field data collected to date from these sediment pins show a high degree of variability, inconsistency, and apparent invalid data. These problems can be due to three factors: insensitivity of the method relative to the small quantities of sediment accumulation (i.e., measurement uncertainties of ±0.007 m/yr are similar to or greater than actual sedimentation of 0.002 m/yr), 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. Human disturbance is likely due to the many volunteer monitoring and management efforts at MLK marsh. The discrepancy between the method sensitivity and the rates of sediment accumulation is a more significant concern for this Project. It renders the method fairly ineffective at providing quantitative data necessary for evaluating project performance. Sediment accretion monitoring may resume in the future with new methods (e.g., SET tables as described in WWR 2002 and Boumans and Day 1993), if the other approach used this monitoring period (described below) to estimate ongoing sedimentation do not provide a level of certainty agreed to by the Consent Decree Parties.

For the current monitoring period, we tried an alternative approach to estimate sediment accretion utilizing other data already being collected: topographic cross sections of the site channels that have included 15-35 ft of the adjacent marsh plain (see Figures 3 to 5). Vertical accuracy of each cross section is fairly high and depends largely upon the care of the person holding the survey rod base 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. 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 (Table 3).

To estimate sediment accretion for the 2001-2002 period, we first calculated the average elevation of all marsh plain data points for 2001 and 2002 from the topographic cross sections, separating data for each side of the channel (left bank and right bank). Then we calculated the difference between 2002 and 2001 to obtain change (negative = erosion, positive = sedimentation). Finally, we sorted these data by low and high marsh and calculated an average and a range of sediment accretion for each marsh type.

2.2.2 Results and Discussion

Previous Results. Table 2 shows the sediment pin data collected from 1998 to 2001. In attempting to compare results between methodologies, we identified data validation problems with much of the early data collected by previous contractors. Specifically, the data had been converted between feet and meters at some point which introduced discrepancies of less than 0.1 ft to roughly 0.5 ft. These discrepancies are significant because of the low actual rates of sediment accretion, and since we do not have access to original field notes we cannot resolve any of the problems. Therefore, we have disregarded all the 1998 and 1999 data and can only make calculations based on data collected in 2000 and 2001. Some of that data we also disregarded because it appears the wrong PVC marker may have been measured due to large numbers of PVC markers in the vicinity of certain sediment pins combined with no labeling at time of installation.

Current Results. Table 3 shows the sediment accretion estimates derived from the topographic survey data. From these data, it appears that the low marsh areas accreted sediment over the past year, with sediment accretion rate estimates of 0.01 to 0.05 m/yr, with an average of 0.02 m/yr. High marsh areas appeared to be accreting at a slower rate, on average, than the low marsh areas, and even showed some erosion, with sediment accretion rate estimates of -0.01 to 0.02 m/yr, with an average of 0.01 m/yr. Although these data are not precise enough to show whether sedimentation is occurring at the predicted rate for low and high marsh, it does suggest that low marsh appears to have higher sediment accretion rates than high marsh areas.

2.3 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 drainage basins (Figure 2). 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.

2.3.1 Methods

Monitoring frequency. The original monitoring plan called for monthly monitoring four times during the wet season. During the current monitoring year (2001-2002), we measured pond depth and/or acreage on four dates (Table 1) over a five month period (December to April). We timed measurement dates to follow larger rainfall events. Three of these dates included measuring pond depth and two of these dates included measuring pond acreage. However, instrument failure lost one of the two days of acreage data.

Pond depth is determined by reading water levels on staff gauges in each pond. Two sets of staff gauges have been installed in the seasonal ponds. The first set was installed shortly after construction; the second set was installed between fall and winter of 2000 to upgrade the original staff gauges. Both sets are currently in the ponds. All staff gauges were installed at the lowest point within each pond. The original staff gauges consisted of ¾-inch schedule 40 PVC driven to resistance into the pond bottoms. Each gauge had graduated adhesive staff gauge tape placed on it to show water levels. The replacement staff gauges consisted of 1½-inch galvanized steel slotted angle iron pounded into the pond bottom to resistance. Porcelain-coated steel graduated staff gauges were bolted onto a second piece of slotted angle iron and the combination then bolted onto the angle iron pounded into the pond bottom. If needed for stability, ½-inch steel rebar was also pounded into the pond bottom and attached to the staff gauge.

Pond acreages are determined by walking the pond perimeters with a handheld GPS unit that recorded position once every three seconds. The position file is then downloaded and corrected with a differential correction service. The resulting file is then imported into ArcView GIS to calculate the area of the polygon. EBRPD staff handles the data download and acreage calculations.

The stage-area curves (Figure 6), generated from past and current data, allow estimates of pond acreages from measured depths and vice verse. The data reported in Table 4 state whether they are generated from field data or the stage-area curve.

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). The nearest rainfall monitoring station that records daily totals is the Oakland South station (code OSO, rainfall sensor 45), operated by the Oakland Fire Services Agency. The station is located in the Oakland hills at 1,000 ft elevation, at latitude 37.7830°N and longitude 122.1500°W.

2.3.2 Results and Discussion

Table 4 presents the pond acreage and depth data from late 1998 through mid-2002 and Table 5 presents the rainfall data for the 1998-1999, 1999-2000, 2000-2001, and 2001-2002 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 continued to hold water very well during the current monitoring period. At the peak stage monitoring event of 1 March 2002, total pond acreage was 13.52 acres, far exceeding the performance criterion of 4.5 acres. Pond depths met or exceeded the required range of 10 to 59 cm (0.3 to 1.9 ft) from January to April 2002 (Table 4). Water levels ranged from 1.90 to over 2.50 ft in Pond 1; from 2.40 to over 3.50 ft in Pond 2; and from 1.42 to over 3.50 ft in Pond 3 during the monitoring period. Water levels exceeding the target range are believed acceptable 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. Incidental observations on 5 July 2002 showed that the ponds were almost but not completely dry at that time.

2.4 Tidal Inundation

Tidal inundation is a fundamental aspect of any tidal marsh. In this 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. Tidal inundation evaluates two portions of the site – the low and high tidal marsh area and the intertidal pond.

Tidal inundation was monitored for approximately one-month periods in the summers of 1998 to 2001, per requirements laid out in the MMP (LFR 1999a). These data (Figures 7 and 8 show 2000 and 2001, respectively) indicated full tidal exchange with minimal if any change over time. These acceptable yet static results, combined with budget constraints, led to removal of this parameter for the current monitoring period. Tidal inundation will be monitored in 2003.

2.5 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. Water quality measurements are useful indicators of current or potential problems that may develop in a tidal marsh. 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 testing was performed during 2000-2001 only (WWR 2002).

During the current 2001-2002 monitoring period, we abandoned velocity, turbidity, and water quality testing. Single-event, once per year monitoring of these parameters can provide only limited interpretive value. 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 three parameters required in order to measure trends with more accuracy is currently beyond the scope of the budget for this project. Data results from previous years of velocity and turbidity measurements are included in Table 6 of this report; previous water quality data is included in Table 7. All these data did not reveal any unusual conditions, further supporting their removal from the monitoring effort at the frequency defined in the MMP.

2.6 Aerial Photography

A series of three 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 10. The regional Spartina Control Group contracted for this photography as part of its larger regional effort to map the distribution and spread of the invasive *Spartina alterniflora* in the San Francisco Estuary, and 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. The second aerial photo (Figure 11) was flown 24 July 2001 at a scale of 1:12,000 and was 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 Spartina control group flew the most recent photographs on 26 August 2002 at a scale of 1:6,000 (Figure 12). WWR rectified and created a mosaic image from the multiple photographs.

2.7 Channel Planform Lateral Migration

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 2.1 and through rectified time series aerial photography. The 25 September 2000 rectified aerial photograph currently serves as the baseline data point. One can see from comparing the 2000, 2001, and 2002 photographs (Figures 10 to 12) to the design drawing (Figure 2) that, from a qualitative perspective, the channels were constructed as designed and have remained stable with very little lateral movement. The channel cross sections shown in Figures 3 through 5 confirm this observation.

Field observations indicate that small channels are beginning to form in a few places within the marsh plain. These channels are small, generally less than 0.3 m (1 ft) wide. They appear to be draining 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.

3.0 Biological Monitoring

The monitoring plan (LFR 1999a) included six biological monitoring activities (Table 1). The 2001-2002 monitoring period included all six monitoring activities, though WWR conducts only five of these six activities. 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 3.1, Vegetation
- Section 3.2, *Spartina foliosa* transplants
- Section 3.3, Weed invasion
- Section 3.4, Loafing island vegetation
- Section 3.5, Bird use

3.1 Vegetation

The restored tidal marsh portion of the site is expected to support three habitat zones typical of San Francisco Bay marshes, including an upper zone of peripheral halophytes, 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. Section 2.3 of the MMP (LFR 1999a) requires tidal marsh vegetation monitoring. Two reference sites for marsh vegetation have been identified; Arrowhead Marsh, corresponding to low marsh vegetation dominated by cordgrass; and Damon Marsh, corresponding to high marsh vegetation dominated by pickleweed. Sampling of these reference sites is not part of this monitoring program.

Monitoring of the vegetation within and around the seasonal wetlands is an important component of the monitoring program for the site because of the possible loss of ecological function for shorebirds and waterfowl caused by excessive vegetation growth in these areas. Performance criteria for the seasonal wetland areas distinguishes between the pond bottoms and the surrounding seasonal wetlands. The Performance criterion states that the pond bottoms should develop vegetation cover of less than 20 percent. Additionally, long-term goals for the vegetation cover of the surrounding seasonal wetlands should develop to at least 80 percent across two-thirds of the area and between 20 and 80 percent on the remaining one-third. An additional performance criterion states that no large patches of invasive species should be present. Section 2.4 of the MMP (LFR 1999a) requires seasonal wetlands vegetation monitoring.

3.1.1 Methods

Transect Locations in Tidal Marsh Portion of Site. During the 1998-1999 monitoring period, colonization of the site by intertidal vegetation was at very low densities.

Therefore, permanent transects as specified in the Monitoring and Maintenance Plan were not appropriate at that time to assess the vegetation colonization of the tidal portions of the site. Instead, the vegetation colonization of the site was assessed qualitatively by walking the entire site. A general description of the vegetation distribution was recorded during this survey and a list of all species present was also generated. Those results are reported in LES (1999) and are not repeated here.

Beginning with the 1999-2000 monitoring period, sufficient vegetation colonization had occurred to justify establishment of permanent vegetation transects. In 2000, we established a total of five tidal marsh vegetation transects (Figure 2). Three transects run off a center point located approximately 35 meters north of the intertidal pond in the center of the restored tidal marsh. At that location we placed an orange stake and white PVC pipe to mark the central point. Transect V1 has a bearing of 250 degrees from the center point and runs westerly to the fence at the western edge of the tidal marsh. Transect V2 has a bearing of 70 degrees from the center point and runs easterly to the fence at the eastern edge of the tidal marsh. Transect V3 has a bearing of 150 degrees from the center point and runs southerly across the Intertidal Pond and continues across Seasonal Pond 2 and the seasonal wetlands to the southern edge of the site ending at the fence. Transect V4 traverses the northern part of the site starting at the chain link gate at the southern end of the main parking lot and bearing 70 degrees east across the site to the eastern edge at the fence. Transect V5 runs at a 100-degree easterly angle from sediment pin 8 (SP-8) near the western edge of the tidal marsh east to the fence and running through SP-10.

Transect Locations in Seasonal Wetland Portion of Site. Previous monitoring activities had established six permanent transects in the seasonal wetlands area. At each of the three ponds, two transects began on the drainage divide and extended toward the center of the pond to the staff gauge. The upper end of each transect was permanently marked with a piece of ¾-inch rebar pounded into the ground with a pin-flag attached to permit the easy relocation of the marker. Transect identifications, bearings, and lengths are:

Pond and Transect ID	Compass Bearing to Staff Gauge	Distance (m) to Staff Gauge
1-1	94	77.2
1-2	244	73
2-1	238	85
2-2	340	88
3-1	310	50.9
3-2	94	63.6

Vegetation Sampling and Frequency along each Transect. Surveys consist of delineating each transect into patches of similar vegetation composition based on visual observations. Within each patch, we collected data on species dominance, total species composition, percent cover and stature. Field sampling is performed once each year.

Vegetation Map from Aerial Photograph. Beginning with the 24 July 2001 aerial photograph, we have used remote sensing image analysis tools available as part of the ArcView® and ArcInfo® geographic information system software packages to generate vegetation maps from the aerial photography for the tidal marsh portion of the site. This year we used the aerial photograph flown on 26 August 2002. During both monitoring years, we used the photographs to prepare preliminary vegetation maps that we then field verified during the September 2001 and November 2002 vegetation sampling efforts, respectively. Field verification comprised evaluating species composition and percent cover.

3.1.2 Results and Discussion – Tidal Marsh

We conducted the annual field surveys for the current monitoring period on 5 November 2002, and the aerial photograph for the vegetation map was flown on 26 August 2002. Table 8 presents the tidal marsh vegetation transect data, Figures 13 and 14 show vegetation cover in July 2001 and August 2002, respectively, Table 9 summarizes patch composition for the vegetation maps, and Appendix C presents a complete list of vegetation species observed at the site, indicating new species detected in the 2002 surveys.

Twelve species typical to San Francisco Estuary tidal salt marshes were observed along the five tidal marsh transects. Annual pickleweed (*Salicornia europaea*) continues to dominate the tidal marsh vegetation. Perennial pickleweed (*S. virginica*), salt grass (*Distichlis spicata*), Pacific cordgrass (*Spartina foliosa*), invasive smooth cordgrass (*S. alterniflora*) and hybrids with *S. foliosa*, brass buttons (*Cotula coronopifolia*), salt-marsh arrow-grass (*Triglochin cocinna*), alkali bulrush (*Scirpus maritimus*), sand-spurry (*Spergularia marina*), marsh gum-plant (*Grindelia stricta* var. *angustifolia*), fleshy jaumea (*Jaumea carnosa*), spear scale (*Atriplex patula*) and alkali heath (*Frankenia salina*), were also observed at the site, though not necessarily along a measured transect (i.e., observed during general observations). Below are some basic patterns of vegetation colonization at the site as evidenced by the field data (Table 8), the vegetation maps (Figures 13 and 14), and the data summarized from the vegetation maps:

- There are three general spatial characteristics:
    - Low marsh changed from 2001 to 2002. In 2001, low marsh had a higher overall percent vegetative cover (39%) versus high marsh (29%). In 2002, the reverse occurred; colonization had progressed to 50% in low marsh versus 59% in high marsh.
    - 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 The invasive smooth cordgrass is primarily found in this edge area.

- Vegetation now dominates the site overall, though bare ground still dominates at the southern end of the site. During 2002, vegetation cover along the five field transects ranged between 53 and 76 percent, up from 40 to 57 percent in 2001 and 6 to 47 percent in 2000 (see Figure 15).

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

- The dominant plant species at the site is annual pickleweed.

- The invasive smooth cordgrass has colonized the site, appears to be present as hybrids with the native cordgrass, and is found mostly but not entirely toward the tidal source at the north end of the site.

- Annual pickleweed (*Salicornia europaea*) is the most common tidal marsh species present (see Tables 8 and 9). Perennial pickleweed (*S. virginica*) appears to be increasing in cover from 2001 to 2002 in high marsh, from about 5% to 10%. In low marsh *S. virginica* appears to be decreasing in the same period, from about 5% to 1%. In both cases, the percent cover of individual species are derived from the field transects and may not be fully representative of the entire site.

Transect V1. The southwest portion of the restored tidal marsh, represented by the 159-m Transect V1 (Table 8), has shown considerable colonization by annual pickleweed during 2002. Total percent cover of bare ground dropped from 94% in 2000 to 60% in 2001 to 34% in 2002, showing considerable increases in vegetation cover (Figure 15).

Transect V2. The southeast portion of the restored tidal marsh, represented by the 179-m Transect V2 (Table 8), shows a much greater extent of vegetation colonization (Figure 15). Bare ground dropped from 78% of total transect in 2000 to 56% in 2001 to 28% in 2002, with much of this colonization occurring in the high marsh east of the channel. The low marsh portion of the transect is roughly half bare ground with some algae and the other half is predominantly annual pickleweed with small amounts of perennial pickleweed and salt grass. The high marsh vegetation is more evenly mixed between annual and perennial pickleweed with a patch of native Pacific cordgrass. A small patch of the invasive smooth cordgrass has colonized along the marsh edge.

Transect V3. The southern portion of the restored tidal marsh, represented by the 169-m Transect V3 through the Intertidal Pond (Table 8), is very similar to Transect V2 but with a higher plant diversity at the marsh edge and a fair amount of bare ground (52% of total transect in 2001 to 47% in 2002). The marsh edge includes salt marsh arrow grass, alkali bulrush, salt grass, and cattails. Little additional vegetation colonization occurred along this transect during 2002 (Figure 15).

Transect V4. The northern portion of the restored tidal marsh near the tidal source, represented by the 80-m Transect V4 (Table 8), shows a considerable amount of vegetation colonization (Figure 15), with bare ground comprising 24% of the total transect, down from 58% in 2001 and 66% in 2000. Species diversity is the highest of all transects within the tidal portion of the site. The invasive smooth cordgrass was not found along this transect in 2001, suggesting that control efforts have positively affected this portion of the site. However at the end of transect V4 it appears that a hybrid between *S. foliosa* and *S. alterniflora* occurs. Hybridization between these two species is somewhat common and certain plants throughout the marsh appeared to be hybrids as well.

Transect V5. The central portion of the restored tidal marsh, represented by the 239-m Transect V5 (Table 8), has the greatest amount of vegetation colonization (Figure 15), with bare ground comprising 25% of the total transect, down from 43 in 2001 and 72% in 2000. Annual pickleweed continues to dominate this area, though perennial pickleweed and the native cordgrass are also found here.

Overall Progress of Vegetation Colonization. Based on the field transect and vegetation map data, it appears clear that the site has met its five-year performance criteria in four years of 50% cover in high marsh and progress toward 50% cover in low marsh (see Section 5). 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 Spartina Control Group. From the very limited occurrence of *S. alterniflora* in 2002, it appears that these control efforts are positively affecting the site. The second and possibly 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, it may be acceptable for this species to colonize and it may represent an interim stage. 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.

3.1.3 Results and Discussion – Seasonal Ponds

We conducted the annual field surveys for the current monitoring period on 24 April 2002. Table 10 presents the vegetation transect data and Appendix C presents a complete list of vegetation species observed at the site, indicating species newly observed in 2002.

The vegetation in the drainage basins feeding the seasonal ponds is typical of disturbed upland habitat with weedy exotic herbaceous species and grasses. Bare ground percentage has increased in 2002 relative to 2001, to a range of 24 to 85% in 2002 from 0 to 55% in 2001. This change may be due to a number of factors including pond inundation, pond size, seasonal variation affecting plant propagation, and park maintenance activities to clear undesirable vegetation from the areas surrounding the ponds. As the surveys are done in the spring many of the plants ringing the ponds are just sprouting. The most common species observed in 2002 were cutleaf plantain (*Plantago coronopus*), prickle grass (*Crypsis vaginiflora*), Birdfoot trefoil (*Lotus corniculatus*), sour clover (*Melilotus indica*), California Barley (*Hordeum brachyantherum),* Mediterranean Barley (*Hordeum marinum gussoneanum),* and loosestrife (*Lythrum hyssopifolium*).

3.2 **Spartina foliosa *Transplants***

Tracking success of *Spartina foliosa* transplants has proved infeasible due to the significant efforts at controlling the invasive *S. alterniflora*. These efforts, along with many volunteer efforts to eradicate *S. alterniflora*, have resulted in accidental removal of *S. foliosa*. These efforts have consequently altered the transplant experiment, such that tracking its results is no longer possible. However, tidal marsh vegetation data (Table 8) show that the native cordgrass, *S. foliosa,* appears to be found on the site, assuming the field identification is correct.

3.3 Weed Invasion

Two categories of weed invasion were evaluated – smooth cordgrass (*Spartina alterniflora*) discussed in Section 3.3.1 and other weeds discussed in Section 3.3.2.

3.3.1 *Spartina alterniflora*

Individuals of *S. alterniflora* were observed along the eastern margins of the tidal marsh, and were seen growing within the eastern portion of the marsh plain. Some plants appeared growing next to *S. foliosa* plantings and may be hybridizing. Although we did not estimate patch sizes of *S. alterniflora* (and hybrids), Table 8 shows the percent cover each species occupied along transect surveys. Percent cover decreased along Transects 2, 3, and 4 between 2001 and 2002 surveys. However, in Transect 4 a possible hybrid was observed at the end of the transect. *S. alterniflora* was not found in Transects 1 or 5 during 2001 or 2002. Attempts to define a trend in invasive cordgrass populations may prove to be meaningless due to frequent removal by EBRPD and volunteers in efforts to restrict *S. alterniflora* growth.

Staff from the Spartina Control Group collected specimens in late 2002 for laboratory genetic analysis to determine which species or degree of hybridization is found at the site (K. Zaremba, personal communication, November 2002). Laboratory results will be available in 2003 and will be reported in next year's monitoring report.

3.3.2 Other Weeds

Weed invasion within the tidal marsh area is largely restricted to marsh upland edges and appears minimal. As mentioned above, *S. alterniflora* is colonizing in the marsh area. 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 were present in dense patches and these species were largely restricted to the southern end of the site near the fence line. Staff managed invasive vegetation, with some assistance from volunteers. Most of the work was done by hand.

3.4 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. Perennial pickleweed (*Salicornia virginica*) appears at about 30% coverage on the edges with plant height averaging about 0.3 m. An occasional salt-marsh arrow-grass (*Triglochin cocinna*) can also be found. Island B shows slightly greater vegetation growth than Island A (see Figure 14).

3.5 Bird Use

Appendix D contains the fourth summary of bird use at the site (HNEC 2002b). During this study period (August 2001 to April 2002), trained volunteers from the Golden Gate Audubon Society monitored bird use of the site and of adjacent reference sites. Volunteers conducted four surveys per month, corresponding to four tidal cycles: high, outgoing, low, and incoming.

The restoration site, consisting of tidal wetlands and seasonal ponds, provided significant habitat for shorebirds, waterfowl, and other birds. At least 49 bird species were recorded at the tidal wetlands, and 34 species at the seasonal ponds. Tidal wetlands supported mostly small shorebirds (occasionally in very high abundance). The seasonal ponds supported fairly low numbers of waterfowl, gulls, and shorebirds. Species composition at all sites has remained fairly consistent over the four study seasons. Abundance of birds using the Seasonal Ponds increased in 2001-2002, perhaps because pond depths this season were the deepest on record. Overall, the restoration site provided a mosaic of habitats, including areas with varying degrees of tidal action. This range of habitats supported birds at all tidal cycles, although the site may be especially important as a high-tide refuge for shorebirds, and as a foraging site during incoming tides.

Up to two Burrowing Owls (*Athene cunicularia hypugea*), were seen on surveys during the 2001-2002 study. Owls were seen near nest boxes (primarily mound #1), but breeding by Burrowing Owls was not documented in 2001-2002. Up to six California Clapper Rails (*Rallus longirostris obsoletus*) were seen in Arrowhead Marsh in 2001-2002, within the reference sites. No rails were seen in the restoration area, due to the lack of suitable habitat at this early stage of the restoration. As native salt marsh vegetation develops within the tidal wetlands site, rail habitat should become available.

Key objectives of the restoration included providing suitable potential breeding habitat for California Clapper Rails, and providing foraging and resting habitat for migratory waterfowl and shorebirds. Although a full analysis of these goals will be possible only after the full five-year study, it appears that significant progress toward these goals is being made. The second goal has probably already been met, and the first goal will likely be met after several more years of vegetation development.

4.0 Maintenance

EBRPD carried out a variety of maintenance activities during the 2001-2002 monitoring period. Activities performed during 2002 are listed here.

January
- Picked up litter and debris from inside the New Marsh area.
- Planted replacement shrubs at landscaped areas.
- Spread mulch around shrubs of landscaped areas.
- Repaired fence around New Marsh area.
- Planted native shoreline plants along shoreline.

February
- Irrigation repair in the landscaped areas.
- Planted replacement shrubs at landscaped areas.
- Picked up litter and debris from inside the New Marsh area.
- Sprayed herbicide (Round-up) at Cross-trail area.
- Pruned shrubs in landscaped areas.
- Weeded around shrubs in landscaped areas.

March
- Picked up litter and debris from inside the New Marsh area.
- Planted replacement shrubs at landscaped areas.
- Mowed open area along Cross-trail.
- Pruned shrubs in landscaped areas.
- Weeded around shrubs in landscaped areas.
- Spread mulch around shrubs in landscaped areas.

April
- Picked up litter and debris from inside the New Marsh area.
- Spread mulch around shrubs in landscaped areas.
- Weeded around shrubs in landscaped areas.
- Pruned shrubs in landscaped areas.
- Planted replacement shrubs at landscaped areas.
- Irrigation repair in the landscaped areas.

May
- Irrigation repair in the landscaped areas.
- Weeded around shrubs in landscaped areas.
- Spread mulch around shrubs in landscaped areas.
- Planted replacement shrubs at landscaped areas.
- Pruned shrubs in landscaped areas.
- Irrigation repair in the landscaped areas.

June
- This month was the off-season for regular ranger.
- Volunteers collected native plant seed.
- Volunteers planted native shoreline plants inside New Marsh.
- Staff and volunteers constructed native plant nursery.

July
- Volunteers planted native plants inside New Marsh area.
- Watered landscaped plants.
- Staff and volunteers constructed native plant nursery.
- Weeded around shrubs in landscaped areas.
- Pruned shrubs in landscaped areas.
- Planted replacement shrubs at landscaped areas.
- Irrigation repair in the landscaped areas.
- Picked up litter and debris from inside the New Marsh area.

August
- Picked up litter and debris from inside the New Marsh area.
- Irrigation repair in the landscaped areas.
- Spread mulch around shrubs in landscaped areas.
- Watered landscaped plants.
- Pruned shrubs in landscaped areas.

September
- Irrigation repair in the landscaped areas.
- Picked up litter and debris from inside the New Marsh area.
- Spread mulch around shrubs in landscaped areas.
- Pruned shrubs in landscaped areas.

October
- Picked up litter and debris from inside the New Marsh area.
- Watered landscaped plants.
- Pruned shrubs in landscaped areas.
- Weeded around shrubs in landscaped areas.
- Hand pulled yellow star thistle from inside New Marsh area.
- Mowed inside New Marsh area.

November
- Mowed inside New Marsh area.
- Hand pulled yellow star thistle from inside New Marsh area.
- Picked up litter and debris from inside the New Marsh area.
- Spread mulch around shrubs in landscaped areas.
- Line-trimmed weeds along fence-line of New Marsh.

December (anticipated activities)

- Picked up litter and debris from inside the New Marsh area.
- Pruned shrubs in landscaped areas.
- Line-trimmed weeds along fence-line of New Marsh.
- Planted replacement shrubs at landscaped areas.

5.0 Project Performance and Suggested Modifications

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 is required to meet within a five-year period and the stressor indicators that are intended to identify problems early on that may hinder the ability of the project to meets its performance criteria.

The Port of Oakland restored tidal action to the site on 10 June 1998. Therefore, this report represents the fourth year following restoration. Consequently, the monitoring data presented in the previous sections are expected to show positive progress toward meeting the five-year performance criteria; there is no expectation that the five-year criteria are met after four years.

5.1 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.

5.1.1 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).

Progress toward performance criterion 1-1. At the end of the fourth year following project construction, colonization by tidal marsh vegetation is progressing. Vegetative cover continued to increase in 2002, relative to 2001 and 2000 (Table 8). There are two primary constraints on meeting this performance criterion: establishment of the invasive smooth cordgrass, *Spartina alterniflora* 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. The significance of the annual versus perennial pickleweed establishment is difficult to assess. Technically, the MMP calls for the perennial pickleweed, which is colonizing the site but slowly compared to annual pickleweed. We have not conducted a literature review to assess the ecological significance of the annual versus perennial pickleweed.

5.1.2 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). No *Scirpus maritimus* has been observed elsewhere at the site.

5.2 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.

Progress toward performance criterion 2-1. Comparable numbers and species of shorebirds were found on the "loafing peninsula" in the Eastern Reference site and the restoration sites and the number of species utilizing the restored site increased from the 2000-2001 monitoring period (Appendix D). Therefore, performance criterion 2-1 was met in the 2001-2002 season.

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

Progress toward performance criterion 2-2. Species richness of shorebirds and waterfowl between restored and reference sites in the 2001-2002 monitoring period is comparable, indicating that this performance criterion is being met (Figures 2 and 3 of Appendix D). In all four monitoring periods, shorebird species richness and abundance in the restored tidal marsh has consistently equaled or exceeded that of either reference site. Waterfowl species richness in the tidal marsh was its highest in 2001-2002 and nearly matched that of the reference sites, though abundance was lower. In the seasonal ponds, shorebird and waterfowl species richness was somewhat lower than at both reference sites. Shorebird abundance was generally lower than both reference sites, and waterfowl abundance was comparable to the western reference site and lower than the eastern reference site.

5.3 Ecological Objective 3: Support Intertidal Plant Communities

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

5.3.1 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).

Progress toward performance criterion 3-1. At the end of the fourth year following project construction, colonization by desired tidal marsh vegetation is progressing appropriately. The 2002 vegetation map (Figure 14) indicates total high marsh cover at 59% overall, thereby meeting 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).

Progress toward performance criterion 3-2. At the end of the fourth 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 2002 vegetation map (Figure 14) indicates total low marsh cover at 50% overall, and Figure 15 shows increasing vegetative cover.

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).

Progress toward performance 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 3, 4, and 5 and Table 3). In nearly all instances, it appears that low marsh has already accreted to 5.75 ft Port Datum or above.

5.3.2 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 15 and compare the 2001 and 2002 vegetation maps in Figures 13 and 14, respectively).

5.4 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.

5.4.1 Performance Criteria

Performance criterion 4-1: Seasonal ponds 1 and 2 (see Figure 2) 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).

Progress toward performance criterion 4-1. Both seasonal ponds met this criterion (Table 10).

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).

Progress toward performance 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).

Progress toward performance 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).

Progress toward performance 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).

Progress toward performance 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).

Progress toward performance criterion 4-6. Vegetation surveys for 2002 indicate some decrease in vegetative cover relative to 2000 (Table 10). The basis for this downward change is not immediately evident. It may be possible that a different survey date (24 April 2002 this monitoring period) may have yielded different results, as many of these species emergence is timed relative to rainfall (Table 5) and some species have a relatively short emergence duration. Monitoring in 2003 should reveal whether a problem exists.

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).

Progress toward performance 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 10). These surveys indicate vegetative growth occurs around the pond. In order to obtain area, one of three new, costly methods must be used: additional air photography and vegetation map; topographic data and GIS extrapolation; multiple vegetation perimeter GPS surveys.

5.4.2 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 C). 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.

5.5 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).

Progress toward performance criterion 5-1. Vegetation colonization is progressing toward meeting this criterion. Total vegetation cover in 2002 was lower than in 2001 but mostly still in the range to meet this criterion (Table 10).

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).

Progress toward performance criterion 5-2. Shrub survival was not evaluated quantitatively during this monitoring year. EBRPD inspects shrub health 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.

5.6 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).

Progress toward performance criterion 6-1. Tidal inundation was not monitored this year (see Section 2.4 for details). However, previous monitoring in 2000 and 2001 indicated unrestricted tidal exchange (see Figures 7 and 8).

5.7 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)

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

5.8 Maintenance Objective 2: Maintain Plantings and Habitat Features

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

5.8.1 Performance Criteria

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

Progress toward performance criterion 8-1. EBRPD performed irrigation system repairs throughout the monitoring year (Section 4).

5.8.2 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 during the monitoring period (Section 4).

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

Field evidence of stressor indicator 8-2. Significant efforts to control the invasive smooth cordgrass *Spartina alterniflora* have so altered *S. foliosa* populations that tracking its survival rate is no longer feasible.

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

Field evidence of stressor indicator 8-3. EBRPD pruned shrubs throughout the monitoring year (see Section 4).

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 in 2002, and yellow star thistle was a main focus of weed removal activities (Section 4).

5.9 Maintenance Objective 3: Routine Park Operation

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

5.10 Maintenance Objective 4: Control Mosquito Breeding

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

5.11 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.

6.0 Monitoring Issues and Possible Resolutions

During the current monitoring period, one new issue arose – questionable early sediment pin data (Section 6.1). The outcome of a previously raised issue – record keeping pertinent to vegetation management – is also addressed (Section 6.2).

6.1 Sediment Pin Data Validation Problems

In the process of comparing sediment accretion results from two field methods – sediment pins and average elevations along marsh plain topographic transects – we identified a significant reporting problem with the baseline and six-month data as reported by the two previous monitoring contractors. Between the six-month and one-year monitoring reports (LFR 1999b and LES 1999, respectively), reported values for supposedly identical data points differed in nearly all cases. Some discrepancies were small (less than 0.1 ft) but some were quite large (roughly 0.5 ft). During this period, data reporting units changed between meters and feet, introducing potential for conversion error which likely accounts for the small discrepancies found. However, the small actual sediment accretion falls within the magnitudes of these conversion errors, rendering the data of no value without further data validation. What would be necessary are original field notes, which are not currently available. The large errors, in contrast, have an unknown origin and again require original field notes to seek a resolution.

During the previous monitoring period, we concluded that the errant sediment pin data and low sedimentation rates combine to render the sediment pins an ineffective method for the accretion conditions at this particular site (see discussion in Section 2.2). For the current monitoring year we estimated accretion from comparing average marsh plain elevation differences at each of the five channel cross sections already surveyed by this monitoring effort. These data indicate the site has accreted sediment. We plan to continue this method in the 2003 monitoring period.

6.2 Vegetation Management

In the previous monitoring report (WWR 2002), we presented an issue raised by Steve Granholm at LSA regarding tracking vegetation management activities employed and the outcome of those activities. He had recommended enhanced record keeping and experimenting with management activities.

While EBRPD did not make significant changes to its record-keeping activities, the vegetation management activities did appear to change and the outcome may be evident in the data. EBRPD reduced its level of vegetation removal in 2002 around the seasonal ponds (see Section 4). The field data for the current year (Table 10) indicate a lower percent cover of seasonal wetland vegetation. The correlation between these two items is that increased vegetation management leads to increased seasonal wetland vegetation, though this conclusion is merely a correlation.

Planting of native plants by volunteers did occur during 2002. Locations and species planted were not available to EBRPD staff.

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Arrowhead Marsh Bird Count Volunteers

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
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
Ann Richter
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
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Steve Walsh