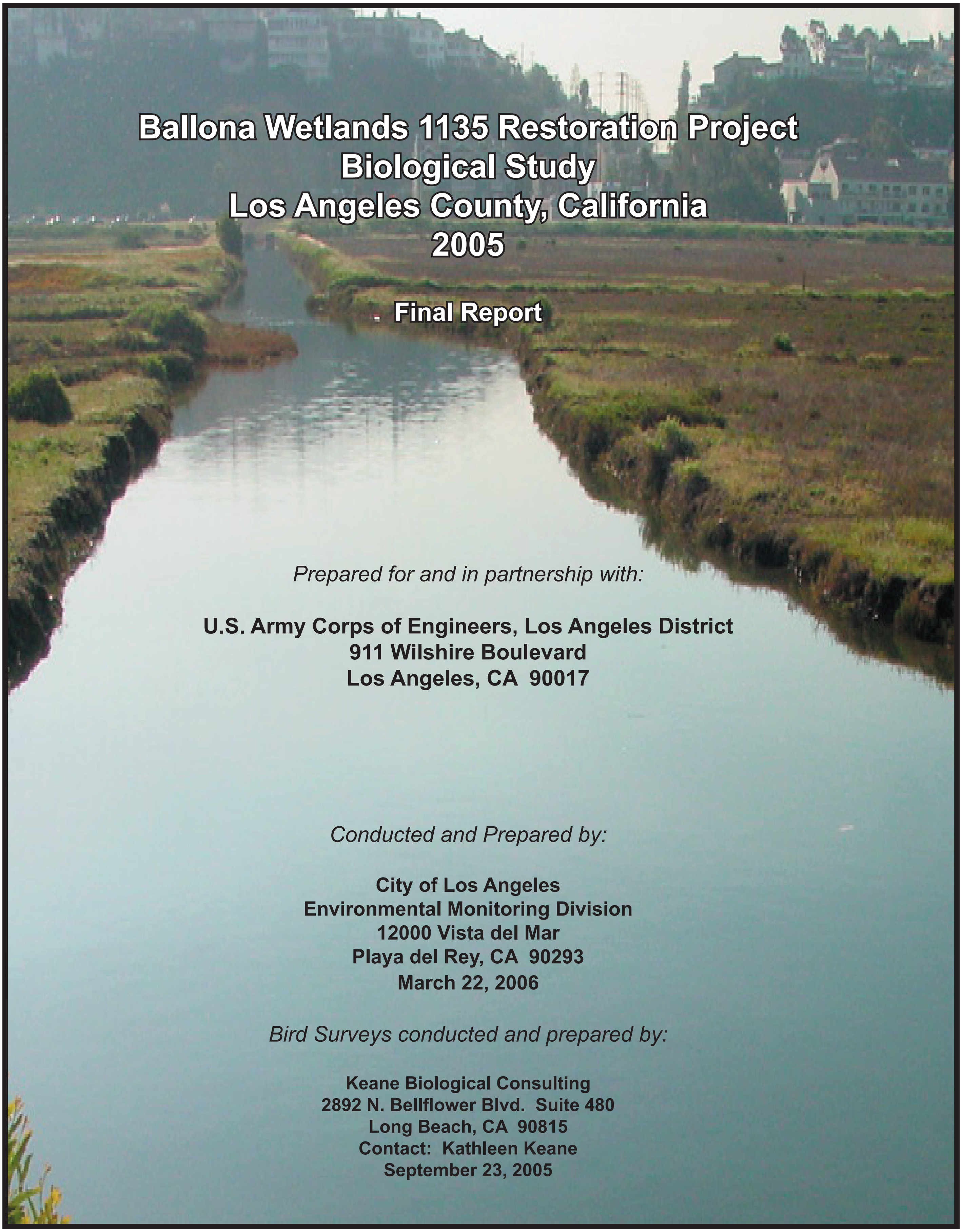

Ballona Wetlands 1135 Restoration Project
Biological Study
Los Angeles County, California
2005

Final Report

Prepared for and in partnership with:

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September 23, 2005

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BACKGROUND

The United States Army Corps of Engineers (USACE) completed the installation of two Self-Regulating Tide Gates (SRTs) and a one-way flap gate retrofit in March 2003 within the Ballona Creek Flood Control Channel Levee between Ballona Wetlands and Ballona Creek (Figure 1). This endeavor is a product of the Ballona Wetlands 1135 Restoration Project (Project) and the associated Ecosystem Restoration Report (USACE 2000). This report evaluated five feasible alternatives. Of these, an initial 1.1 m Mean Lower Low Water (MLLW) inundation target was chosen. Following the SRT installation, the inundation level could be increased to 1.2 m based on results of pre-installation biological surveys and one year of post-installation surveys. The impetus for this project is the implementation of "structural or operational modifications for the purpose of improving the quality of the environment and in the public interest" as provided for in the Water Resources Development Act of 1986, as amended (USACE 2000).

Historically, this site was continuous with an 800+ha, or 8,000,000 m^2, tidal wetland system (Zedler 2001). Road and railway construction in the late 1800s, Ballona Creek channelization in 1934, construction of Marina del Rey in the 1960s, and urban development throughout are a few important events that severely impaired or destroyed Ballona Wetland's natural function. After the Ballona Creek channelization and associated levee construction, the tidal wetlands that constitute the Project site experienced a radical reduction in its tidal prism and hence, suffered limited tidal flushing compared to what they once had.

The City of Los Angeles (City) has agreed to participate as a 25% non-federal partner, or local sponsor, in this Ballona Wetlands 1135 Restoration Project (USACE 2000). In doing so, the City directed its Environmental Monitoring Division (CLAEMD) to participate in the Technical Committee and complete the remaining post-installation biological surveys to monitor any effects to the ecosystem as a result of the Project. These surveys include vegetation, seine-caught fish and megainvertebrates, benthic macrofauna (infaunal and epibenthic invertebrates), and avifauna (birds).

The City agreed to commence fieldwork in spring 2005. However, during an August 26, 2004 meeting, a subset of the Technical Committee (USACE, National Marine Fisheries Service, City staff, Kathy Keane Biological Consulting, and MEC Analytical Systems/Weston Solutions) determined that a Fall 2004 vegetation survey was necessary for assessing any change in the halophyte, *Salicornia virginica* (common pickleweed) stands with respect to increased inundation as a result of the SRT installation. By doing this, the data continuum, or sampling event chronology, would not be interrupted and would serve to strengthen support in future decisions to be made.

At another meeting subsequent to the release of the Fall 2004 vegetation survey report,

Figure 1. Map of Ballona Wetlands study area. Bars represent vegetation transects, triangles represent benthic macrofauna, and circles represent siene stations.

the Technical Committee decided to reduce frequency and timing of vegetation surveys from spring and fall to a single survey in late summer. The rationale for the change in frequency was to reduce occupation of the site and minimize impacts to habitat by trampling. No additional information was perceived to be gained from a semiannual monitoring frequency other than bolstering seasonal trend information. The rationale for the change of season was to acquire data that had not yet been collected within this project and minimize impacts to the nesting or brooding California endangered Belding's savannah sparrow (BSS), *Passerculus sandwichensis beldingi*, and provide insight to a previously unsampled season.

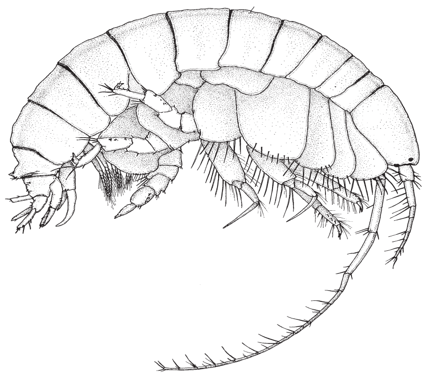
These *post hoc* decisions are consistent with language contained in the Monitoring and Adaptive Management Plan (USACE 2000). Not only is *S. virginica* considered a fundamental, prominent vegetation element of a salt marsh community for this geographic locality, focused monitoring for this species in this particular study is essential for assessing the BSS habitat.

Also, at the August 2004 meeting and upon consensus of the Technical Committee, it was decided to fulfill the objective to increase tidal inundation from 1.1 m to 1.2 m MLLW based on the data results thus far.

After lengthy consideration, it was determined by the Technical Committee in December 2005 that additional survey components would be necessary to accurately assess the effects of the inundation increase from 1.1-m to 1.2-m scheduled for September 2006, in general and specifically to the BSS habitat. These additional components include mapping the lateral inundation extent prior to and immediately following the inundation increase and subsequent comparison with original inundation maps and schematic diagrams contained in the Ecosystem Restoration Report (ERR) Section 1135 Project, Modifications for Improvement of the Environment (USACE 2000).

Presented here are the findings of seine-caught fish and megainvertebrates, benthic macrofauna, and vegetation surveys conducted by CLAEMD during the summer of 2005. Additionally, bird surveys were conducted and addressed by Keane Consulting (Keane Biological Consulting 2005) which are incorporated in the document, but slightly modified from its original format.

BENTHIC MACROFAUNA



INTRODUCTION

The benthic macrofauna community is fundamental in its position in the complete ecosystem, for not only estuarine situations, but any aquatic environment, be it marine or freshwater. It functions as an essential component in trophic structure for all levels, even remotely connected. From birds to fish to megainvertebrates, the animals residing in and directly on the sediment are vital to the sustainability of the ecosystem.

Benthic macrofauna are highly responsive to perturbations stemming from natural environmental changes to anthropogenic influence. They do so by their immediacy with the sediments, which have differential affinities for pollutant retention and transport, their lack of motility, and their differential sensitivities and tolerances to various pollutants and other environmental condition changes. Accurate detection and interpretation of these responses provide compelling and unsurpassed insight into overall ecosystem integrity, from which other survey types can be leveraged.

Benthic macrofauna were sampled in summer 2001 for the pre-SRT installation baseline assessment and summer 2003 post-installation monitoring. Both were conducted by MEC Analytical Systems for USACE. No benthic macrofauna survey was conducted in 2004.

MATERIALS AND METHODS

The summer survey was conducted over two days in September 2005, between the hours of 0700 and 1200 on September 1st and between 0700 and 1030 on September 2nd. The survey was conducted during these hours to coincide with neap tidal conditions and avoid extremes in water depth and current velocity. Three replicates at each of eight stations were sampled as close to the same locations in previous surveys as possible (see map Figure 1) using a hand, or coffee-can, core device (10-cm diameter, 13-cm depth). A GPS was used to capture waypoint coordinates (Table 1).

Station names were modified from original numeric designations to alpha numeric to accommodate CLAEMD's database and differentiate between macrofaunal and seine surveys. In doing so, macrofauna stations have been relabeled, for example, from Station 1 to BWB1. The prefix acronym stands for Ballona Wetlands benthic. Taxonomic nomenclature follows that utilized by SCAMIT (2001).

Table 1. Station coordinates for Summer 2005 macrofauna survey.

Station	Latitude	Longitude
BWB1	N33 57.852	W118 27.007
BWB2	N33 57.797	W118 26.938
BWB3	N33 57.907	W118 26.913
BWB4	N33 57.764	W118 26.754
BWB5	N33 57.937	W118 26.803
BWB6	N33 57.791	W118 26.620
BWB7	N33 57.841	W118 26.571
BWB8	N33 57.778	W118 26.602

Macrofaunal samples were transferred from the coffee-can core to a 1-liter Nalgene polycarbonate container in the field over a 0.5-mm mesh screen. The material retained on the screen was placed back into the 1-liter Nalgene container; any animals adhering to the screen were carefully removed with forceps and added to the container. Containers were filled to no more than 80% volume with sample material to allow for proper fixation of animals. A 0.2% solution of propylene phenoxytol was initially added to each container to relax the animals to prevent fragmentation during preservation. After a minimum of 30 minutes, samples were preserved in a 10% buffered seawater-formalin solution. All containers were labeled inside and outside then transported to the laboratory. After a minimum of 48 hours, samples were washed carefully with freshwater to remove sediments, using a low-flow hose dispenser to avoid animal fragmentation and again over a 0.5-mm mesh screen and transferred to a 70% ethanol solution. Samples were then sorted by phylum and a miscellaneous minor-phyla composite, subject to quality assurance standards, and distributed to appropriate taxonomists for identification to lowest possible taxon, preferably species.

Measurements for salinity (ppt), temperature (°C), dissolved oxygen (mg/L), and pH were taken at channel mid-depth using a YSI Inc. 600XL Sonde multi-parameter monitoring system. Data were stored directly on a laptop computer. Sensors for conductivity, dissolved oxygen (DO), and pH were calibrated prior to each survey in accordance with the manufacturer's specifications. These parameters were measured once for each station for approximately 10 minutes. Values were recorded after the instrument was allowed to stabilize.

Various community parameters, traditional diversity indices, phylodiversity indices, and parsimony analyses of endemism (PAE) were generated from the data set. Phylodiversity indices incorporate phylogenetic structure, assuming taxonomic congruence, and by differentially weighting hierarchical nestedness accordingly (Clarke and Gorley 2001 and Clarke and Warwick 2001). Software for this survey's analyses included Microsoft Excel, Microsoft Word, Adobe InDesign Creative Suite, PAUP, Mesquite, Primer v. 5, SigmaPlot, and SigmaStat.

RESULTS AND DISCUSSION

Physico-chemical Measurements

Temperature ranged from 21.78˚C to 25.89˚C, salinity from 20.92 ppt to 32.42 ppt, dissolved oxygen (DO) concentration from 2.25 mg/L to 12.22 mg/L, and pH from 7.61 to 8.20 (Table 2).

Macrofaunal Community Composition and Abundance

There were 4,626 individuals representing 44 taxa collected during this survey. A complete account of taxa and abundances is found in Appendix A. Those recorded in excess of 100 individuals were Oligochaeta (1466), members of the *Capitella capitata* complex (1017), *Monocorophium insidiosum* (501), *Polydora nuchalis* (438), *Grandidierella japonica* (415), the provisionally named *Drillactis* sp BW1 (275), and *Streblospio benedicti* (236).

In addition to *Drillactis* sp BW1, new to the Ballona Wetland's historical macrofauna species list (a compilation of previous Project report species lists not shown) is the tanaid *Tanaopsis cadieni* (Figure 2), which occurred as a single individual.

Figure 2. Drawing of *Tanaopsis cadieni*

Table 2. Summary of water quality physico-chemical parameters for Summer 2005.

Station	Date	Time	Tide* (MLLW)	Water Depth (m)	Temp (˚C)	Salinity (ppt)	DO%	DO (mg/L)	pH
BWB1	2-Sep-05	8:20	1.341	0.3	21.78	32.42	101.40	7.37	7.90
BWB2	2-Sep-05	8:40	1.322	0.2	21.95	28.65	81.20	6.02	7.79
BWB3	2-Sep-05	7:50	1.249	0.5	22.31	31.10	66.60	4.82	7.68
BWB4	2-Sep-05	9:30	1.342	0.5	21.83	25.20	63.00	4.77	7.61
BWB5	1-Sep-05	8:00	1.299	0.2	23.14	28.69	86.00	6.22	7.61
BWB6	1-Sep-05	9:30	1.274	0.2	22.94	21.71	161.50	12.22	8.12
BWB7	1-Sep-05	10:58	1.066	0.5	25.89	20.92	31.00	2.25	8.20
BWB8	1-Sep-05	10:26	1.178	0.2	23.55	22.06	62.00	4.66	8.19

* measurements are in meters at Santa Monica NOAA Tidal Station.

In describing this species, Sieg and Dojiri (1991) used type material collected at depths ranging from 45 m to 719 m in coastal waters of the Southern California Bight. This species presence in the Wetlands may be the first record from such a shallow depth and an estuarine environment. A single specimen of a mytilid bivalve, provisionally named *Adula* sp BW1, may be the first appearance of this possible Asian-origin non-indigenous species (NIS) to the eastern Pacific (Tony Phillips, CLAEMD, Paul Valentich Scott, Santa Barbara Museum of Natural History, and Eugene Coan, California Academy of Sciences; personnal communication). This specimen does not match any material from the Eastern Pacific or Panamic provinces.

The provisional *Drillactis* sp BW1 also represents what appears to be a new species of sea anemone and first record of the genus from the entire Eastern Pacific. The genus *Drillactis* heretofore, has only been found at three localities; one species from off Japan and Korea, one species from New Zealand waters, and one species from near Provincetown, Cape Cod.

The most abundant sample was BWB6(1) with 535 individuals (Table 3). The least abundant sample was BWB5(1) with 11 individuals. The most taxa-rich samples were BWB3(1) and BWB3(3) with 14 each, followed by BWB3(2) and BWB1(3) with 13, and BWB1(2) with 12. The least taxa-rich samples, arbitrarily defined as five or less, included replicate 1 of both BWB2 and BWB5 and all replicates of BWB7. Representatives of Oligochaeta occurred within every replicate (24). Additionally, those taxa occurring in 10 or more samples/replicates were *Monocorophium insidiosum* (20), *Capitella capitata* complex (19), *Polydora nuchalis* (18), *Grandidierella japonica* (18), *Acteocina inculta* (17), *Drillactis* sp BW1 (14), *Streblospio benedicti* (13), and *Ampithoe valida* (10).

As shown by Margalef’s species richness index (d), the five most diverse samples were located nearest the Levee apertures [BWB3(3), BWB3(1), BWB1(2), BWB1(3), and BWB3(2) with values of 3.04, 2.68, 2.44, 2.35, and 2.03, respectively, Table 3]. Conversely, samples BWB2(1), BWB8(3), BWB7(3), BWB7(1), and BWB7(2) were least in this sample set metric (d), ranging from 0.92 to 0.58. Intuitively, this polarized pattern of Levee aperture-proximal samples being high and the more distant being low in the range of values is to be expected. Ranking of stations based on community parameters and diversity indices reveals patterns, or lack thereof, in community structure.

Values for the Shannon-Weiner function or index (H’), showed the five most diverse samples were BWB2(3), BWB3(3), BWB6(3), BWB2(2), BWB4(1), ranging from 1.89 to 1.60. Information theory suggests that these samples represent a relatively high degree of uncertainty in predicting the correct species or taxa of the next individual collected. Those

Table 3. Summer 2005 macrofaunal community parameters, various biodiversity measures, and phylodiversity indices by replicate (sample) including species (taxa) richness (S), abundance (N), Margalef's species richness (d), Pielou's evenness (J') Shannon-Weiner function (H' log base e), Simpson's index (1-λ'), taxonomic distinctness (Δ^*), variation in taxonomic distinctness ($\Lambda+$), total taxonomic distinctness ($s\Delta+$), and total phylogenetic diversity ($s\Phi+$).

	Community Parameters/Diversity Indices						Phylodiversity Indices			
Station(rep)	**S**	**N**	**d**	**J'**	**H'**	**1-λ'**	**Δ***	**Λ+**	**sΔ+**	**sΦ+**
BWB1 (1)	9	95	1.76	0.65	1.43	0.70	90.57	291.44	840.70	700.93
BWB1 (2)	12	91	2.44	0.61	1.50	0.68	80.91	404.33	1096.42	811.94
BWB1 (3)	13	164	2.35	0.59	1.52	0.69	90.33	486.62	1154.31	894.50
BWB2 (1)	5	76	0.92	0.81	1.30	0.70	71.04	519.85	445.87	391.75
BWB2 (2)	10	345	1.54	0.74	1.71	0.77	82.71	772.26	839.09	615.21
BWB2 (3)	11	288	1.77	0.79	1.89	0.81	77.07	655.66	926.41	679.97
BWB3 (1)	14	129	2.68	0.59	1.56	0.67	76.87	826.83	1135.20	734.16
BWB3 (2)	13	371	2.03	0.50	1.29	0.56	76.49	711.98	1108.02	717.80
BWB3 (3)	14	72	3.04	0.68	1.80	0.76	91.67	493.07	1268.92	893.43
BWB4 (1)	9	58	1.97	0.73	1.60	0.76	48.91	762.34	732.06	532.65
BWB4 (2)	7	40	1.63	0.72	1.40	0.67	70.33	793.17	564.50	468.96
BWB4 (3)	8	53	1.76	0.68	1.42	0.68	52.71	665.13	683.86	568.96
BWB5 (1)	5	11	1.67	0.91	1.47	0.82	76.02	402.13	435.52	409.18
BWB5 (2)	9	270	1.43	0.69	1.53	0.71	79.09	675.68	771.56	585.32
BWB5 (3)	7	81	1.37	0.78	1.51	0.74	95.67	596.45	598.86	525.54
BWB6 (1)	10	535	1.43	0.60	1.39	0.66	73.18	665.58	850.72	632.65
BWB6 (2)	8	78	1.61	0.76	1.59	0.76	94.33	458.55	713.02	586.40
BWB6 (3)	9	404	1.33	0.80	1.75	0.81	87.45	498.02	805.64	630.82
BWB7 (1)	5	248	0.73	0.63	1.02	0.58	61.49	770.32	348.29	325.54
BWB7 (2)	4	170	0.58	0.54	0.75	0.41	58.26	485.43	314.03	309.18
BWB7 (3)	5	167	0.78	0.54	0.88	0.49	60.35	941.59	388.99	316.12
BWB8 (1)	8	280	1.24	0.68	1.41	0.68	85.05	396.82	728.07	586.40
BWB8 (2)	8	117	1.47	0.67	1.39	0.70	70.13	515.18	721.51	563.44
BWB8 (3)	6	483	0.81	0.77	1.38	0.70	74.14	530.53	520.37	439.07

samples having relatively low uncertainty in this regard, thus considered less biodiverse, are all three replicates of BWB7 reflected by values ranging from 1.02 to 0.75. Interestingly in this manner, Replicate 2 of BWB3 had a relatively low Shannon-Weiner value of 1.29. Closer inspection of the data reveals that, although having the second highest species richness (S) value (13), a large amount of unevenness reflected by this sample is due to the high abundances of oligochaetes, *Grandidierella japonica*, and *Capitella capitata* complex.

Contrarily, Simpson's index (1-λ) values indicated that the five most diverse samples were BWB5 (1), BWB2 (3), BWB6 (3), BWB2 (2), and BWB6 (2), ranging from 0.82 to 0.76. Based on probability theory, these values suggest a fairly low probability that any two random individuals would be of the same species or taxa.

The recurring polarization, evident in several of the community parameters and diversity indices, is fairly congruent (Table 3); however, several other indices diverge with no apparent trend. Commonly, the SRT and one-way flap gate proximal stations diverge to the relatively diverse end while those most distant from the levee openings (BWB6, BWB7 and BWB8) tend to venture to the opposing, diversity-poor end. This pattern is most apparent for species richness, Margalef's, Shannon-Weiner, taxonomic distinctness, total taxonomic distinctness, and total phylogenetic diversity. Elsewhere, for example Simpson's, Pielou's species evenness, and abundance, a moderate to complete breakdown of this scheme is equally obvious.

Examination of the three replicate composite means, the same general patterns of traditional diversity indices, as well as the phylodiversity indices, are repeated with only slight variation in station ordinations (Table 4). In fact, high

Table 4. Summer 2005 macrofaunal community parameters, various biodiversity measures, and phylodiversity indices by replicate means (stations). Abreviations are the same as Table 3.

	Community Parameters/Diversity Indices						Phylodiversity Indices			
Station	S	N	d	J'	H'	1-λ'	Δ*	Λ+	sΔ+	sΦ+
BWB1	23	116.7	4.62	0.59	1.85	0.77	85.96	575.25	2022.59	1187.08
BWB2	15	236.3	2.56	0.70	1.89	0.81	82.01	664.58	1286.52	873.55
BWB3	24	190.7	4.38	0.51	1.63	0.64	79.64	641.72	2094.70	1246.88
BWB4	11	50.3	2.55	0.67	1.60	0.73	55.56	714.32	920.22	649.01
BWB5	9	120.7	1.67	0.75	1.65	0.77	83.68	675.68	771.56	585.32
BWB6	11	339.0	1.72	0.71	1.70	0.78	82.77	586.75	958.02	694.50
BWB7	7	195.0	1.14	0.52	1.00	0.58	60.46	861.18	567.84	432.48
BWB8	10	293.3	1.58	0.62	1.43	0.70	77.27	512.92	899.96	640.66

fidelity in ranking occurs with Margalef's, taxonomic distinctness, total taxonomic distinctness, and total phylogenetic diversity between all samples and station replicate means.

Confirmed non-indigenous species included *Monocorophium insidiosum*, *M. acherusicum*, *Grandidierella japonica*, *Streblospio benedicti*, *Venerupis philippianarum*, *Theora lubrica*, and *Mytilus galloprovincialis*. The latter two species did not occur within the pre-installation 2001 survey.

Table 5. Taxa richness values since 2001.

	Number of Taxa		
	2001	2003	2005
BWB1	20	21	23
BWB2	20	19	15
BWB3	24	16	24
BWB4	10	17	11
BWB5	12	7	9
BWB6	12	14	11
BWB7	10	9	7
BWB8	9	14	10

To conserve historical comparison, strict focus on the conceptually limited mean replicate taxa richness and Shannon-Weiner values (Tables 5 and 6, respectively) reveal community change among surveys. Taxa richness has increased sequentially at BWB1 from 2001, while BWB2 and BWB7 decreased in the same manner (Table 5). BWB3 and BWB5 decreased in 2003, only to elevate again or even match 2001 (BWB3). Among the three surveys, BWB4, BWB6, and BWB8 peaked in 2003.

Comparing the Shannon-Weiner ordinations of stations among surveys reveals moderately inconsistent tracking with taxa richness (Table 6). In 2005, three stations increased in value from 2003, while all others decreased. Similarly, three stations increased in 2003 from 2001.

Table 6. Shannon-Weiner diversity index values since 2001.

	Shannon-Wiener Index		
	2001	2003	2005
BWB1	2.67	0.99	1.85
BWB2	2.13	1.25	1.89
BWB3	1.01	1.51	1.63
BWB4	1.44	2.01	1.60
BWB5	2.03	1.70	1.65
BWB6	1.97	1.96	1.70
BWB7	1.38	1.56	1.00
BWB8	1.92	1.69	1.43

After community parameters (traditional diversity and phylodiversity indices) of station replicate means were calculated, the collection of values was subject to non-metric multi-dimensional scaling (Clarke and Gorley 2001 and Clarke and Warwick 2001). This ordination was generated from similarity of stations based on normalized Euclidean distances of the various measures. This technique is used to elucidate patterns not readily apparent, especially for larger data sets. Mean abundance (Figure 3) and total taxonomic diversity values (Figure 4) were then mapped onto the ordination using size-graduated filled circles. This serves to reiterate the polarization previously described, but using the suite of values simultaneously.

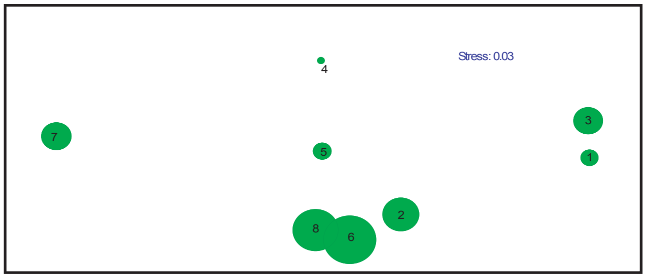


Figure 3. Non-metric multi-dimensional scaling (NMDS) of macrofaunal community with abundance mapped as size-graduated circles.

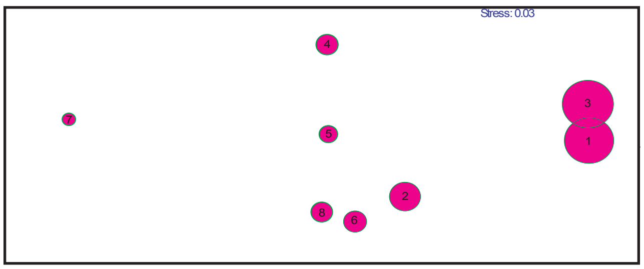


Figure 4 Non-metric multi-dimensional scaling (NMDS) of macrofaunal community with total taxonomic distinctness mapped as size-graduated circles.

characters), was performed on the macrofauna data collected via hand-coring. A parsimony analysis of co-occurring species or PACOS (analogous to conventional r-mode analyses in many ecology studies), grouping species based on their shared distribution patterns, was also performed.

The PAE cladogram (Figure 5) grouping the station samples reveals a pattern difficult to interpret. The bottom large subclade groups all of the samples from Stations BWB3, BWB4, and BWB6. Additionally, as denoted by the long branch lengths leading to the apical clade comprised of samples BWB1(3), BWB3(2), BWB3(3), and BWB3(1), the most species-rich collection with a total of 13, 13, 14, and 14 taxa found, respectively. Character mapping found a few species with restricted distributions within the large basal subclade. The capitellid polychaete *Notomastus hemipodus* and the Japanese littleneck clam *Venerupis phillippinarum,* were both recorded from BWB3(1) and BWB3(3). The Pacific littleneck clam *Protothaca staminea* was collected from all three replicates at BWB3. The remaining large apical subclade contains all of the samples taken from BWB7 and BWB8. Character mapping does not show any distinct species distributions clearly attributable to this observation.

Over the entire PAE cladogram however, species mapping (maps available upon request) does show slightly higher average abundances of *Capitella capitata* complex, Oligochaeta in the large apical sub-clade, and higher average abundance of *Ampithoe valida* in the lower large subclade, responsible for the general grouping between the two large sub-clades.

The PACOS cladogram (Figure 6) presents a clear visualization of species grouping in a near perfect occurrence gradient. The lesser occurring species in our sampling are found along the bottom portion of the cladogram with the very short branch lengths, indicating their relative rarity. The more abundant and widely occurring species group together in the apical-most clade with the longest branch lengths. The most widely occurring taxon was Oligochaeta collected at all 24 of the 24 sampling events. This was followed by the amphipod *Monocorophium insidiosum* collected 20 times, the polychaete *Capitella capitata* Complex (19), another amphipod *Grandidierella japonica* and a polychaete *Polydora nuchalis* both collected 18 times, the cephalispidean *Acteocina inculta*, and *Drillactis* sp BW1 collected 14 times.

SUMMARY

A general pattern emerges from comparison of traditional biodiversity measures and phylodiversity indices amongst samples. The southernmost stations (BWB6, BWB7, and

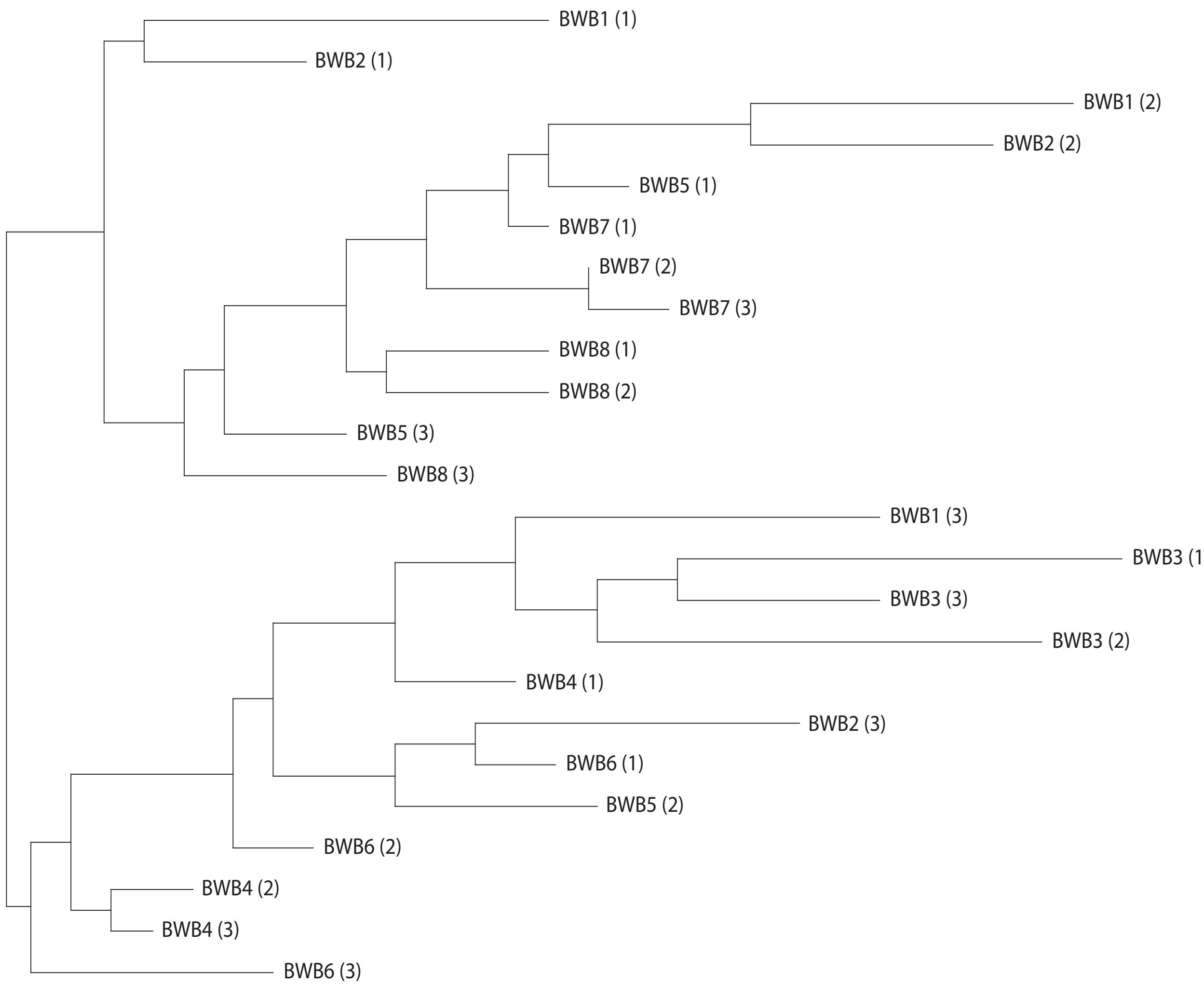


Figure 5. Parsimony analysis of endemicity (PAE) Q-mode cladogram of Summer 2005 benthic macrofauna. The relative positions of termini (objects; stations) are determined by their shared descriptors (species; taxa). The branch lengths are determined by relative species loading for any given station.

BWB8) have generally lower values than those closer to Levee apertures (SRTs and one-way flap gate), often the SRTs.

This is most apparent with Margalef's and simple species richness, Shannon-Weiner, and the phylodiversity indices; taxonomic distinctness, total taxonomic distinctness, and total phylogenetic diversity. This intuitive expectation deteriorates slightly with Simpson's index and more so with Pielou's evenness. Furthermore, this same pattern is supported by the non-metric multi-dimensional scaling routine as well as the parsimony analyses of endemicity.

Stations most abundant in the pollution-tolerant and perturbation-indicating polychaete *Capitella capitata* complex, were BWB6, BWB7, and BWB8 with none to relatively few at those immediate to Levee apertures. Those stations having oligochaetes in excess of 100 individuals were BWB3(2), BWB8(3 and 1), BWB7(1), and BWB2(2) with 238, 223, 143, 140, and 135, respectively.

The high rainfall in winter and spring of 2005 could have affected the benthic macrofauna community in Ballona Wetlands by mere flow and radical physico-chemical parameter changes at that time. The characterization of the community as sampled and analyzed in

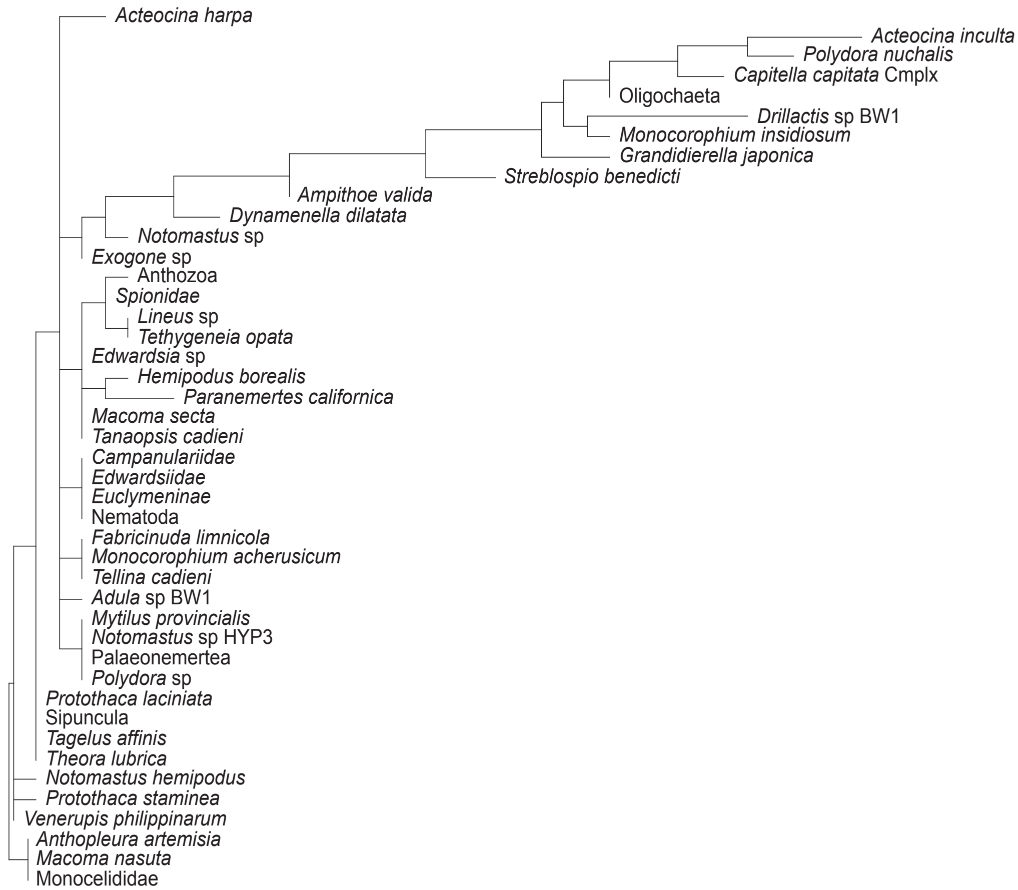


Figure 6. Parsimony analysis of co-occurring species (PACOS) cladogram of Summer 2005 benthic macrofauna. The relative positions of termini (objects; species) are determined by their shared descriptors (samples). The branch lengths are determined by relative co-occurence.

late summer, well after rainfall events, quite possibly represents a late stage of transitional recovery.

It is recommended that both sediment chemistry and granulometry be included in any macrofaunal assessment to further characterize the community and lend explanatory power in its assessment.

Addtionally, exploration of the freshwater benthic macroinvertebrate (BMIs) and estuarine insect larvae components, specifically in the upper reaches of the channel network, might further the characterization of the whole ecosystem.

SEINE-CAUGHT FISH AND MEGAINVERTEBRATES

INTRODUCTION

Organisms living within waters of coastal wetlands may include coastal marine species, estuarine species more tolerant of varying physical/chemical conditions, and/or freshwater species. The type of community depends on the degree of tidal exchange, ability to access the wetlands, freshwater input sources, depth and breadth of channels, physico-chemical conditions, and contaminant levels.

Channels of the Ballona Wetlands were sampled in September of 2005 to provide data on fish populations using the wetlands after implementation of the Ballona Wetlands Ecosystem Restoration Project. Fish were sampled previously in Ballona Wetlands in the early 1980's (Swift and Frantz 1981), early 1990's (Soltz 1991), and mid 1990's (Haglund et al. 1996). The same methods used during the 2001 baseline study and the 2003 and 2004 post-installation surveys conducted by MEC were implemented by the City of Los Angeles' personnel for the 2005 seine survey. The September 2005 survey was performed to provide further information on the development of populations under post-installation conditions.

This chapter has been previously labeled "Fish" by previous authors. We chose to include for the first time in the Project, a record of the demersal epibenthic invertebrate (megainvertebrate) contribution to the biological community. To accommodate these animals and encompass both groups, we have modified the title to "Seine-Caught Fish and Megainvertebrates".

This chapter presents the results of the September 2005 seine-caught fish and megainvertebrate survey and comparison of this year's results to previous surveys. It also includes an investigation of the fish and megainvertebrate community structure using parsimony analysis of endemicity (PAE).

MATERIALS AND METHODS

Organisms were sampled at eight stations in the Ballona Wetlands (Figure 1). The stations were located as close as possible to the sampling stations established during the 2001 baseline study and the 2003 and 2004 post-installation surveys previously conducted by MEC (USACE 2001, 2004, and 2005). Waypoint coordinates of sample locations were captured with GPS (Table 7).

Table 7. Station coordinates for Summer 2005 seine survey.

Station	Latitude	Longitude
BWF1	N33 57.857	W118 27.006
BWF2	N33 57.776	W118 26.899
BWF3	N33 57.914	W118 26.913
BWF4	N33 57.774	W118 26.748
BWF5	N33 57.889	W118 26.825
BWF6	N33 57.792	W118 26.614
BWF7	N33 57.803	W118 26.657
BWF8	N33 57.778	W118 26.602

The summer season survey was conducted over two days in September 2005; between the hours of 0800 and 1500 on September 21

Figure 7. Example of seine sampling at Station BWF4 during the Summer 2005 survey.

Figure 8. Example of seine catch at Station BWF4 during the Summer 2005 survey.

and between 1000 and 1900 on September 22. The survey was conducted during these hours to coincide with neap tidal conditions and avoid extremes in water depth and current velocity. Water depths ranged from approximately 0.5 m to 0.75 m.

Organisms were collected using a standard beach seine, 15-m (49-ft) long by 1.2-m (4-ft) deep with a mesh size of 0.48 cm (3/8-in) in the wings and 0.3 cm (1/8 in) in the bag. The seine was oriented perpendicular to channel width, and sampling involved walking the seine across the channel from bank to bank, while maintaining a connection between the lead-line and substrate. Two replicate hauls, spaced approximately 10 m apart were taken at each station. Representative photographs taken at Station 4 during the summer 2005 survey are shown in Figures 7 and 8. Common and scientific names are according to Nelson et. al. (2004), SCAMIT (2001), and Miller and Lea (1972).

All fish were identified to species. Up to 100 fish per species collected at a station were individually measured by centimeter size class and then collectively weighed to the nearest gram. Any additional fish after 100 were batch weighed in aliquots and the abundance was then calculated from the total weight of the aliquots. Fish were returned to the water immediately after processing. Some juvenile fish were transported to the laboratory for identification by inspection of minute morphological characters using a dissection scope.

Sparse to moderate cover of submerged widgeon-grass (*Ruppia maritime*) occurred in the channels at Stations BWF6, BWF7, and BWF8 which are located furthest from the main channel. Vegetation floating on the surface of the water was nearly absent at Stations BWF6 and BWF7, but was present in modest amounts at Station BWF8.

Water quality measurements were taken using the same methods as for macrofauna sampling. Additionally, current speed, at two-thirds the depth of the water column, was measured with a Marsh-McBirney Model 2000 portable flowmeter.

Station names have been modified from original numerical designations to alpha numeric to accommodate our database and differentiate between macrofaunal and seine surveys. In doing so, seine stations have been re-labeled, for example, from Station 5 to BWF5. The prefix acronym stands for Ballona Wetlands fish.

Table 8. Summary of water quality physico-chemical parameters for Summer 2005.

Station	Date	Time	Tide* (MLLW)	Water Depth (m)	Current (m/sec)	Temp (˚C)	Salinity (ppt)	DO%	DO (mg/L)	pH
BWF1	21-Sep-05	7:57	1.215	0.5	0.00	17.92	26.77	16.20	1.29	7.09
BWF2	21-Sep-05	8:46	1.496	0.3	0.02	16.30	24.77	32.80	2.76	7.19
BWF3	22-Sep-05	18:05	0.269	0.5	0.05	21.70	27.61	125.60	9.40	7.77
BWF4	21-Sep-05	10:05	1.733	0.8	0.02	18.64	25.49	12.20	0.98	7.10
BWF5	22-Sep-05	13:45	1.373	0.5	0.01	22.70	23.81	77.80	5.89	7.46
BWF6	21-Sep-05	12:47	1.446	0.5	0.01	19.92	16.13	30.00	2.46	7.37
BWF7	21-Sep-05	13:53	1.072	0.5	0.01	19.95	22.18	100.30	8.09	7.77
BWF8	22-Sep-05	10:20	1.637	0.5	0.05	19.37	20.93	36.70	2.90	7.33

* measurements are in meters at Santa Monica NOAA Tidal Station.

RESULTS AND DISCUSSION

Physico-Chemical Measurements

Temperature ranged from 16.30 C to 22.70 C, salinity from 16.13 ppt to 27.61 ppt, dissolved oxygen concentration from 0.98 mg/L to 9.40 mg/L, and pH ranged from 7.09 to 7.77 (Table 8). Current speed was minimal to quiescent due to the tidal stages of sampling.

Seine Composition and Abundance

Ranked species abundance at all stations combined is presented in Table 9. Species abundance and biomass per haul are presented in Table 10.

A total of 3,640 fish representing six species were collected at Ballona Wetlands during the September 2005 survey (Table 9). Western mosquitofish (*Gambusia affinis*), hereafter mosquitofish, was the most abundant species collected at all stations combined, with 2,719 individuals.

Mosquitofish were collected at all eight stations, and were caught in the highest numbers at Stations BWF6, BWF7 and BWF8, which are located farthest from the tide gate and near to freshwater sources (see Figure 1). Sailfin molly (*Poecilia latipinnis*) was also collected, in much smaller quantities than mosquitofish, at Stations BWF6, BWF7, and BWF8 (Table 10). Both of these species are found in still to slow-moving waters and prefer vegetated areas in both fresh and brackish water.

California killifish (*Fundulus parvipinnis*) was second in abundance with 721 individuals collected (Table 9). California killifish is a common resident of small bays and tidal sloughs in Southern California. This species accounted for 19.8% of the individuals collected and together with the mosquitofish constitute 94.5% of the total abundance of fishes collected in 2005. California killifish were collected at four stations (Stations BWF2, BWF3, BWF4, and BWF5) and were the numerically dominant species at the most SRT-proximal stations such as BWF3, BWF4, and BWF5 (Figure 1).

Table 9. Ranked fish species abundance for Summer 2005 seine survey.

Common Name	Species	Total Catch
Mosquitofish	*Gambusia affinis*	2719
California killifish	*Fundulus parvipinnis*	721
Topsmelt	*Atherinops affinis*	91
Longjaw mudsucker	*Gillichthys mirabilis*	86
Arrow goby	*Clevelandia ios*	16
Sailfin molly	*Poecilia latipinna*	7
		3640

Topsmelt was third in abundance with 91 individuals collected, and was present at four stations (Table 10), though over 91% of them

Table 10. Ballona Wetlands Summer 2005 seine survey fish occurrence, abundance, and biomass by station and replicate. Although some of the listed species did not occurr in the 2005 survey (e.g., cheekspot goby, diamond turbot, staghorn sculpin, etc.), they have been retained within the table for historical reference.

	Station	**1**		**2**		**3**		**4**		**5**		**6**		**7**		**8**	
	Replicate	1	2	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Common Name	**Species**	Number of individuals															
Arrow goby	*Clevelandia ios*	4				10	2										
California killifish	*Fundulus parvipinnis*			7	26	117	470	25	52	12	12						
Cheekspot goby	*Ilypnus gilberti*																
Diamond turbot	*Hypsopetta guttulata*																
Sailfin molly	*Poecilia latipinna*							1	1				2		1	1	1
Longjaw mudsucker	*Gillichthys mirabilis*	49	13			8	8			2		1	3			1	1
Mosquitofish	*Gambusia affinis*	3		2	8	3	7	6	5	3		66	1176	7	86	1199	148
Silverside (unid.)	Atherinidae																
Staghorn sculpin	*Leptocottus armatus*																
Topsmelt	*Atherinops affinis*	1				1	5		83	1							
	Abundance per replicate	57	13	9	34	139	492	32	141	18	12	67	1181	7	87	1201	150
	Mean total abundance	**35**		**23**		**315**		**86.5**		**15**		**624**		**47**		**675**	
	Number of species	**4**		**2**		**5**		**4**		**4**		**3**		**2**		**3**	
		Wet Weight (g)															
Arrow goby	*Clevelandia ios*	2				5.5	0.7										
California killifish	*Fundulus parvipinnis*			1.8	6.7	55	235	7	16	49	48						
Cheekspot goby	*Ilypnus gilberti*																
Diamond turbot	*Hypsopetta guttulata*																
Sailfin molly	*Poecilia latipinna*							0.4	1				4		1	1	1
Longjaw mudsucker	*Gillichthys mirabilis*	500	100			25	23.6			39		21	18			2	12
Mosquitofish	*Gambusia affinis*	0.8		0.2	0.7	0.5	0.7	0.7	1.7	1		23	400	2	29	392	50
Silverside (unid.)	Atherinidae																
Staghorn sculpin	*Leptocottus armatus*																
Topsmelt	*Atherinops affinis*	0.5				0.1	1		20	0.2							
	Biomass per replicate	503	100	2	7.4	86.1	261	8.1	38.7	89.2	48	44	422	2	30	395	63
	Mean Biomass	**302**		**4.7**		**173**		**23.4**		**69**		**233**		**16**		**229**	

were collected in the second replicate of Station BWF4 (Table 10). Topsmelt abundance was reduced compared to the summer surveys done in 2003 (1,743 collected) and 2004 (1,023 collected).

Longjaw mudsucker (*Gillichthys mirabilis*) was a close fourth in abundance with 86 individuals collected, and was present at five stations (Table 10). This species of goby prefers a mud bottom in shallow water and is more tolerant of stress than other gobies. This would explain why longjaw mudsuckers were found at stations as diverse as the tidally influenced Stations BWF1 and BWF3 and also at Stations BWF6 and BWF8, which are subject to freshwater inputs. This species was the most abundant at BWF1 (Table 10).

Arrow goby (*Clevelandia ios*) was present with 16 individuals collected at two stations (Table 10). This was less than the 187 individuals collected at four stations in August 2004, but more than the three that were collected in the June and August 2003 studies combined.
Mean total abundance per station ranged from 15 individual fish per haul at Station BWF5 to 675 fish per haul at Station BWF8 (Table 10). Mean fish biomass per station ranged from 4.7 g/haul at Station BWF2 to 302 g/haul at Station BWF1. Fish species richness was greatest at Station BWF3, where five different species were collected (Table 10). Species diversity was lowest at Stations BWF2 and BWF7, where two different species were collected at each station.

Megainvertebrates were highly depauperate. Only two *Navanx inermis* and two *Palaemon ritteri* occurred at Station BWF3. A single *Pachygrapsus crassipes* occurred at Station BWF5.

Historical Comparison

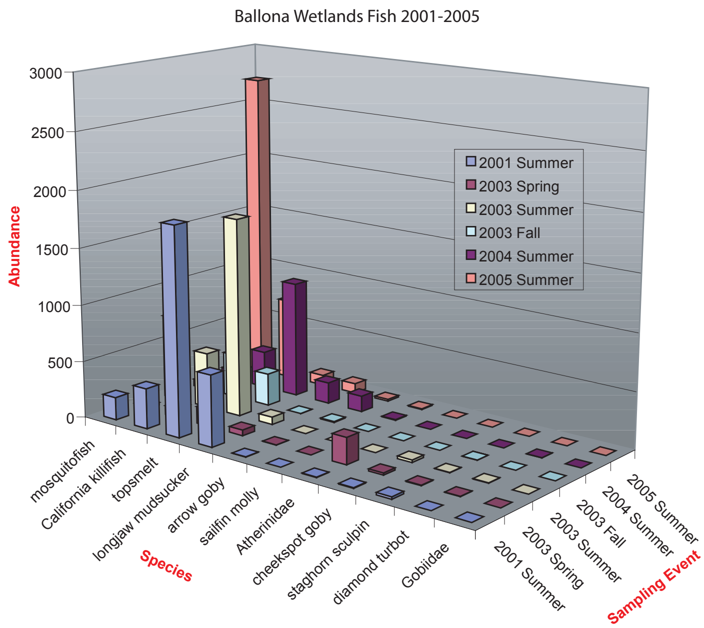


Figure 9. Fish species occurrence and abundance from 2001 to 2005.

Water quality measurements in September, 2005 were quite different from what was measured in the summer surveys of 2003 and 2004, especially for salinity, pH, and temperature. Salinity and pH during the 2005 survey was much lower than what was measured in 2003 and 2004. The salinity ranged from 16.1 to 27.6 ppt in 2005, lower than measurements taken during the 2003 and 2004 surveys (25-29 and 26.2-31.0 ppt, respectively). pH ranged from 7.09 to 7.77 in 2005, lower than measurements taken during the 2003 and 2004 surveys (7.7-8.1 and 7.8-8.7, respectively). The range in temperatures found in 2005 was also lower than those found in the earlier surveys. The temperatures ranged from 16.3 to 22.7 ºC in 2005 while in 2003 and 2004 the temperature range was 21.7-27.2 and 26.2-31.0 ºC, respectively.

Comparison of the collection times among surveys showed fair consistency, and thus suggest stronger influence from tidal stage, marine water temperature, and atmospheric conditions than time of day.

The marked differences in water physico-chemical measurements were likely the result of a brief, two-day storm that delivered 0.45 in of rain late September 20th through the early morning of the 21st. This rainfall caused more freshwater to enter the wetland system from direct accumulation, creeks, and general runoff and would have resulted in the lower salinities and pH measured during the 2005 survey. Additionally, lower temperature measures might also have been influenced by the reduced insolation resulting from storm-related cloud cover.

The September 2005 total abundance (3,640 individuals) was similar to the August 2003 survey (3,066), but differed dramatically from that measured in the July 2004 survey (1,766).

The fish assemblage also was similar to the summer surveys of 2001, 2003, and 2004, but the six species collected in 2005 was the lowest number of species found in any of the five previous surveys (Figure 9). We suspect the slightly lowered species diversity resulted from the influx of freshwater into the wetland system from the preceding storm and its effect on the physico-chemical conditions.

Sampling later in the summer season also might have affected the number of species collected. Seasonal sampling performed by MEC in 2003 (USACE 2004) showed that the abundance and diversity of the fish are greatest during the middle summer months (July and August) and decline during the early summer and early fall months (June and October). The September 21 and 22 survey was sufficiently late in the summer season that it took on the characteristics of a fall survey as evidenced by the lack of topsmelt adults collected compared to the earlier summer surveys (Figure 9). Adult topsmelt may migrate into embayments in spring and summer to spawn, but migrate back to inshore coastal areas by fall (Alllen et al. 2002, Emmett et al. 1991, Zedler 1982).

It should also be noted that during the 2004 summer survey, when eight species were collected, two of the species (Pacific staghorn sculpin and diamond turbot) were represented by only one individual. Prior to sampling at Station BWF3 in 2005, a diamond turbot was seen, but none were collected within the seine. This shows that once-a-year sampling may not be effective in collecting all the species truly present at the location.

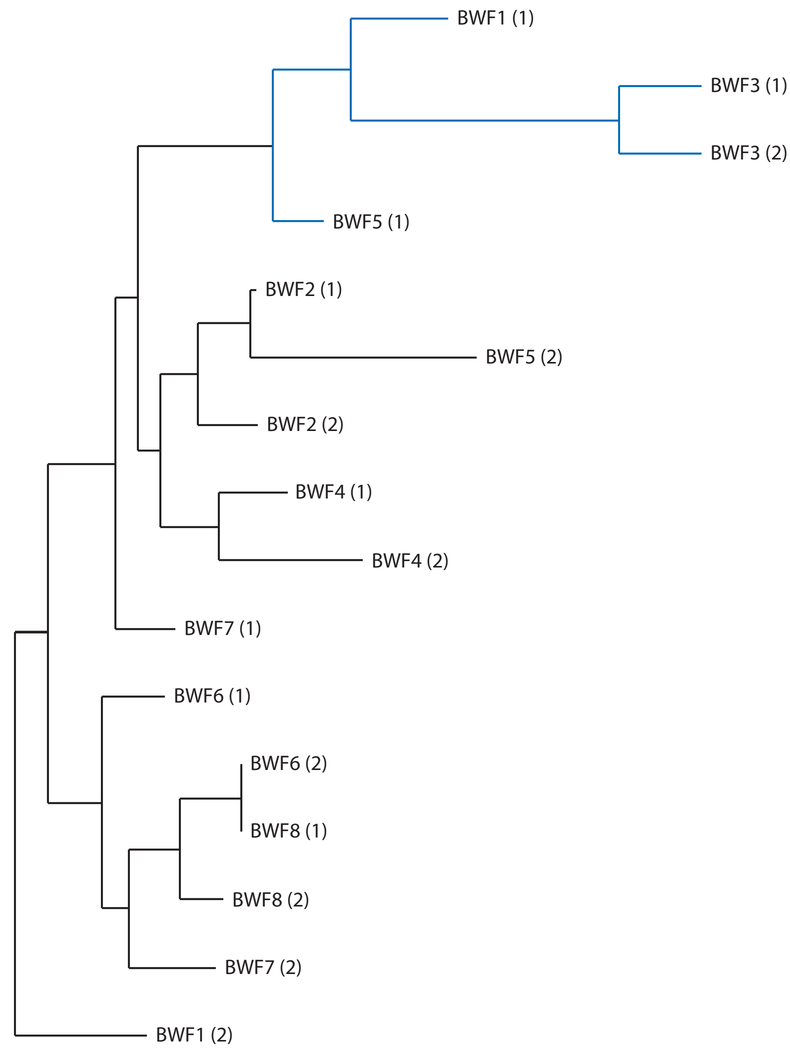


Figure 10. Parsimony analysis of endemicity (PAE) Q-mode cladogram of Summer 2005 Seine Survey. Upper-most clade (blue) is composed of all Levee proximal replicates.

Parsimony Analyses

Parsimony analysis of endemicity or PAE (Crisci et al. 2003) classifying or grouping our station samples (analogous to taxa) by their shared species (analogous to characters) was performed on the fish and megainvertebrate data collected in the seine hauls. Additionally, a parsimony analysis of co-occurring species or PACOS (analogous to conventional R-mode analyses in many ecology studies), grouping species based on their shared distribution patterns was performed.

The PAE cladogram (Figure 10), grouping the station samples, reveals an interesting pattern. The basal-most sample BWF1(2) represents one of the most species-depauperate hauls; only 13 individuals of a single species (longjaw mudsucker). The most apical grouping of stations, consisting of BWF5(1), BWF1(1), and the long branch grouping BWF3(1) and BWF3(2), represent the samples with the highest taxon richness with 4, 4, 7, and 7 species collected, respectively (note the longer branch lengths indicating the greater diversity). Mapping species distributions back onto the cladogram is one of the many advantages character-based classificatory methods have over conventionally used distance methods, allowing a rapid heuristic visualization of what species are responsible for the groupings in the final cladogram. Species or character mapping revealed that the arrow goby was restricted to samples BWF1(1), BWF3(1), and BWF3(2) helping to hold that species-rich clade together (maps available upon request).

Additionally, the tightly nested but exiguous distributions of *Navanax inermis* and *Paleomon ritteri* co-occurred at BWF3(1) and BWF3(2), nearest the SRTs, contributing to the close grouping of the two replicate samples at that station. The California killifish strongly defines the large apical clade bordered by BWF4(2) and BWF1(1), albeit is absent at BWF1(1). The sailfin molly has an imperfectly nested distribution being found in the two subclades composed of BWF4(1) and BWF4(2), and the other composed of BWF6(2), BWF8 (1), BWF8(2), and BWF7(2). The topsmelt helps link the apical-most clade together composed of BWF1(1), BWF3(1), BWF3(2), and BWF5(1), and is also found at BWF4(2). The moderately occurring longjaw mudsucker is absent from the grade of stations bordered by BWF7(1) and BWF2(1). The most abundant and widely occurring mosquitofish groups the majority of the samples together, being found within all samples except the basal-most BWF1(2) and BWF5(2). Both of these samples are relatively species depauperate with only one and two species collected, respectively.

The PACOS cladogram (Figure 11) presents a clear visualization of species grouping in a near perfect occurrence gradient. The least occurring species in our sampling was the striped shore crab (*Pacyhgrapsus crassipes*) with only a single occurrence, *Navanax inermis* and *Palaemon ritteri* occurring twice, the arrow goby three times, the topsmelt five times, and finally the most frequently occurring species all grouped together with the sailfin molly, California killifish, longjaw mudsucker, and mosquitofish collected six, eight, nine, and 14 times, respectively (note the longer branch lengths representing greater number of occurrences).

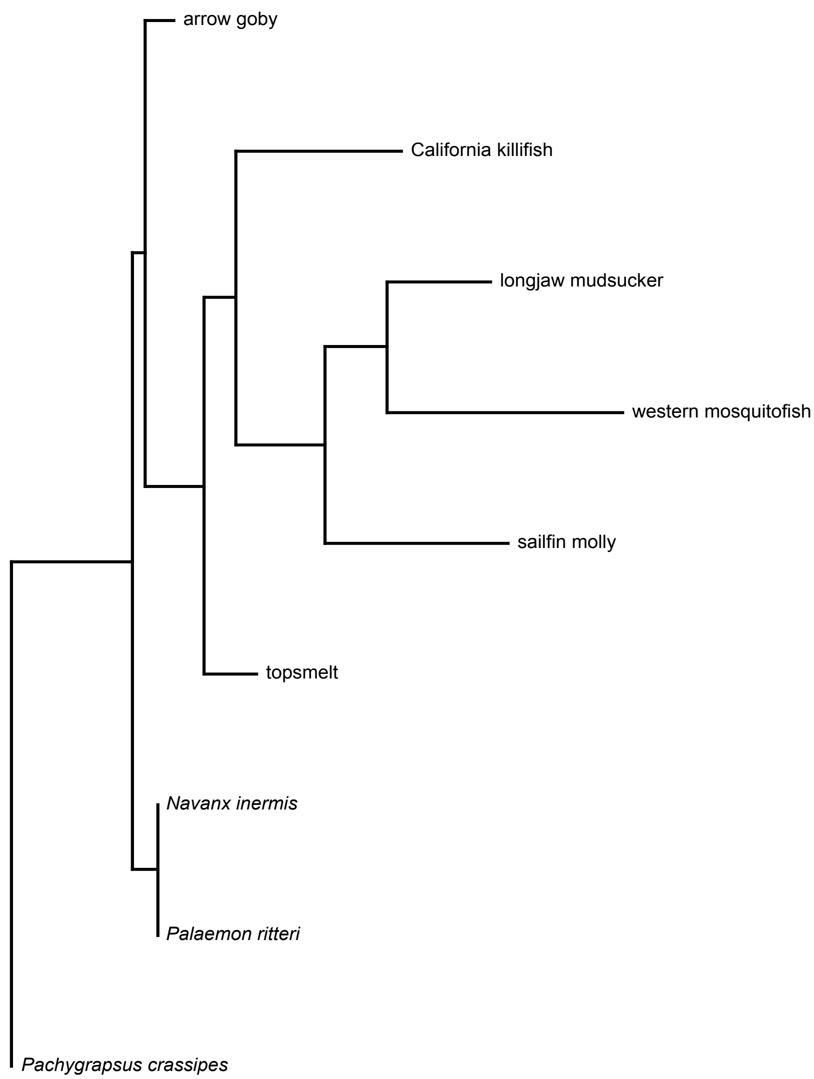


Figure 11. Parsimony analysis of co-occurring species (PACOS) cladogram of Summer 2005 Seine Survey.

SUMMARY

Fish and megainvertebrates were sampled at eight stations in the Ballona Wetlands on September 21 and 22, 2005. A total of 3,640 fish representing six species and five megainvertebrates representing three species were collected. The fish species assemblage was dominated by estuarine species common in southern California coastal wetlands and included the introduced mosquitofish and sailfin molly. The most abundant species were mosquitofish and California killifish, which made up over 91% of all the fish collected during the 2005 survey. The other species collected, in order of decreasing abundance were topsmelt, longjaw mudsucker, arrow goby, and sailfin molly. The most diverse assemblages of fish were collected at Station BWF3, which is located nearest to the SRTs. Stations BWF2 and BWF7 had the lowest species diversity, as they did in the 2004 survey.

Total fish abundance was similar to the summer survey of 2003, but quite different than summer of 2004. The fish species assemblage was also similar to, but did show less diversity, than the summer surveys conducted in 2001, 2003 and 2004. The decrease in diversity was likely due to rainfall immediately preceding the survey and/or the lateness of the summer sampling, however, the variability associated with beach seine sampling alone could easily explain the loss of only two survey-infrequent species. Diamond turbot, which was collected in both 2003 and 2004, was not collected in 2005. However, a single specimen was observed at Station BWF3 prior to sampling, further proof of the vagaries of sampling.

Megainvertebrates were extremely low in both diversity (three species) and abundance (five individuals) relative to samples from Ballona Lagoon Marine Preserve collected a month later using the same technique, equipment, and personnel.

VEGETATION

INTRODUCTION

In general, tidal wetlands are unique in that soil pH and salinity parameters are often highly variable. Tidal cycles and their variability, fresh and saltwater inundation, and climate contribute to the unique hydro- and halo-dynamic complexity of such a system (Zedler 2001).

In specific, southern California tidal wetland soil chemistry predictions are exacerbated, even in relatively undisturbed sites, by inherent complexities of the Mediterranean climate with it's associated low rainfall and hot atmospheric temperatures, inter- and intra-annual rainfall variability (El Niño, La Niña), often small but steep watersheds, and multiplicity of soil types. Furthermore, the absence of true reference or pristine conditions in this geographic region (PERL 1990) adds to the mystery of soil chemistry and vegetation patterns alike.

Salt marsh vegetation is often restricted to only a small set of specialized vascular plants relative to other communities. The unique environmental conditions afforded by this land and seascape interface select for highly to moderately specialized species capable of exploitation and tolerance. Elevational homogeneity combined with the radical physico-chemical dynamics, further attenuate the species pallette. Southern California marshes having poor tidal circulation are often dominated by, if not monotypic of, the common pickleweed, *Salicornia virginica* (Zedler 1982), as is the case in Ballona Wetlands.

Essentially, Ballona Wetlands is of the herbaceous series group, pickleweed series, with an association of common pickleweed-jaumea-saltgrass (Sawyer and Keeler-Wolf 1995). Focused mapping in the future according to this classification scheme will likely resolve other more narrowly defined associations (Brad Henderson California Department of Fish and Game, personal communication).

Never before has there been a summer survey associated with this Project. Capturing this season now represents data accumulated for three of the four seasons with only winter not having been sampled. The summer survey was conducted in late August. Presented herein are the results of the CLAEMD's Summer 2005 vegetation survey.

MATERIALS AND METHODS

The design of the vegetation component in the Project was to establish 10 permanent transects at various locations (Figure 1 and Table 11) in the channel network. Eight of these are located at various distances (3-m, 5-m, 9-m, and 18-m) parallel to their closest channel (Figure 1). The remaining two transects (30-m) are located somewhat equidistant between and perpendicular to the two main channels. Transects 2 and 5 (3-m), Transects 1 and 6 (5-m), Transects 3 and 7 (9-m), Transects 4 and 8 (18-m), and Transects 9 and 10 (30-m) were positioned to attempt to capture changes that occur in vegetation percent cover, canopy height, and soil chemistry as a result of increased inundation in a stepwise manner. The latter two transects function as control transects. The equidistant-transect pair feature offers replication.

A review of pertinent documents, previous reports (USACE 2000, USACE 2001, USACE 2003a, USACE 2003b, USACE 2004, USACE 2005), and examination of expected tidal profiles were performed prior to initiation of the survey. Dr. Philippa Drennan (Loyola Marymount University, Department of Biology) provided taxonomic verification of any undetermined field identifications. Taxonomic nomenclature followed that of Hickman (1993) and Rosatti (2004).

Surveys were conducted in the Ballona Wetlands salt marsh on August 22 and 23, 2005. A -0.06 m low tide occurred at 05:46 PDT and a 1.65 m high tide occurred at 12:06 PDT on August 22nd. The survey commenced at approximately 07:45 PDT and ended at approximately 14:30 PDT having completed Transects 1, 2, 3, 4, 9, and 10. On August 23rd, a 0.18 m low tide was at 06:20 PDT and a 1.65 m high at 12:45 PDT. Transects 5, 6, 7, and 8 were sampled to complete the 2005 survey. As feasible, vegetation trampling throughout the survey was minimized by walking in a single-file.

Table 11. Locations and descriptions of transects sampled in Summer 2005.

Transect	Distance from Channel (m)	Coordinates at Start Position	Transect Direction from Start	Original Descriptions and GPS Errors from Chambers Group
1	5	N 33° 57.830 W 118° 26.972	130°	North side of west channel; 12’ GPS error
2	3	N 33° 57.832 W 118° 26.979	311°	North side of west channel; 13’ GPS error
3	9	N 33° 57.754 W 118° 26.880	293°	West side of west channel 14’ GPS error
4	18	N 33° 57.749 W 118° 26.886	284°	West side of west channel 14’ GPS error
5	3	N 33° 57.947 W 118° 26.788	195°	North side of east channel 16’ GPS error
6	5	N 33° 57.917 W 118° 26.813	199°	North side of east channel 15’ GPS error
7	9	N 33° 57.908 W 118° 26.798	203°	South side of east channel 16’ GPS error
8	18	N 33° 57.904 W 118° 26.794	206°	South side of east channel 13’ GPS error
9	30	N 33° 57.865 W 118° 26.911	223°	Between main and west channels, centered north; 15’ GPS error
10	30	N 33° 57.802 W 118° 26.882	219°	Between main and west channels, centered south; 15’ GPS error

Re-bar markers that identify the starting ends of transects were located using a DGPS unit. The blue, marine epoxy cement, applied to each rebar transect marker as a visual flag in fall 2004, indeed assisted discovery once in the vicinity during this survey.

Once re-bar markers were located, transects were established with a 30-m measuring tape as parallel to their respective channel as possible using visual estimation. Compass headings given in previous reports were used to assist tape positioning if parallelism was not readily apparent. In an attempt to minimize data bias from trampling of vegetation in quadrats by personnel foot traffic, the right and left sides of transects were designated relative to the opposing end of the transect from the rebar marker, restricting sampling to the left and foot traffic to the right.

In five-meter intervals beginning at the five-meter mark, a 0.25 m^2 PVC quadrat was placed on the left side of the transect (Figure 12). The tallest plant shoot within the quadrat was selected and measured against a staff incremented to the nearest centimeter for canopy height (Figure 13). Identification of all species contained within the quadrat and their respective percent coverage were made. The California Native Plant Society (CNPS) Cover Diagram was used as a model for percent coverage estimates (Anne Klein, California Native Plant Society, personal communication). This process was repeated throughout each transect for a total of six quadrats per transect and ending at the 30-m mark. Additionally, percent litter cover (leaf/organic), algal mat, trash, bare ground, weather conditions, and other comments were recorded.

Perspective-view digital photographs were taken for all transects from both directions. Top-view digital photographs were also taken for every quadrat. Not all photographs are included herein, only examples of each type of image are provided (Figures 12 and 13).

Figure 12. Example of transect placement.

Soil chemistry samples were taken from 5 to 15 cm depth within all transects at Quadrats 2 and 4 (10 m and 20 m, respectively) after completing the vegetation component. Approximately 0.5 L samples were contained in labeled, plastic locking bags and placed on ice. At the end of the field day, all samples were transported to the laboratory for salinity and pH analyses.

Samples were extracted using a 1:1 deionized (DI) water to soil ratio by volume (150 mL DI: approximately 150 g of soil) and mixed thoroughly with a hand mixer to attain sample pastes. Pastes were then split and pH was

Figure 13. Example of quadrat and canopy height measurement.

measured using a Thermo Orion A Plus Meter. The subsamples remained undisturbed for approximately 24 hours before being filtered through Number 41 filter paper using vacuum filtration. Conductivity (µS/cm) was then measured from the filtered water (solution). Measurements were converted to salinity by the following equation (APHA 1998, 2520B):

$$S = a_0 + a_1 R_t^{1/2} + a_2 R_t + a_3 R_t^{3/2} + a_4 R_t^2 + a_5 R_t^{5/2}) + \Delta S$$

where,

$$\Delta S = [t - 15/1 + 0.0162(t - 15)](b_0 + b_1 R_t^{1/2} + b_2 R_t + b_3 R_t^{3/2} + b_4 R_t^2 + b_5 R_t^{5/2})$$

R_t = C (sample at t) /C (KCl solution at t)

All soil chemistry data (Table 12) and vegetation data were entered into the CLAEMD database. Data from previous surveys conducted by Weston Solutions (formerly MEC Analytical Systems, Carlsbad, CA) were used with data from this survey for temporal analyses. Software for this survey's analyses included Microsoft Excel, Microsoft Word, Adobe InDesign Creative Suite, PAUP, Mesquite, SigmaPlot, and SigmaStat.

A comprehensive list of vegetation species observed or known to occur within or adjacent to the Project area is presented in Appendix B.

Table 12. Soil chemistry from transects in Balllona Wetlands, Summer 2005. Numbers (10 or 20) following hyphen in Station name indicate distance (m) on transect from beginning.

Station	Distance from Channel (m)	pH	Salinity (ppt)	Soil Appearance
BWV1-10	5	7.32	14.12	soft
BWV1-20	5	7.43	11.55	very soft
BWV2-10	3	7.05	10.58	very soft
BWV2-20	3	7.49	11.88	very soft
BWV3-10	9	7.59	16.56	firm
BWV3-20	9	7.34	26.59	very firm
BWV4-10	18	7.53	18.53	very firm
BWV4-20	18	7.62	17.54	very firm
BWV5-10	3	7.59	11.67	soft
BWV5-20	3	7.54	17.90	soft
BWV6-10	5	7.66	16.69	soft
BWV6-20	5	7.66	21.03	soft
BWV7-10	9	7.89	21.39	firm
BWV7-20	9	7.77	9.49	very dry
BWV8-10	18	7.66	22.91	powdery
BWV8-20	18	7.72	10.32	very dry
BWV9-10	30	7.31	9.75	very dry
BWV9-20	30	6.93	9.96	very dry
BWV10-10	30	7.73	13.51	dry
BWV10-20	30	7.46	13.37	dry

RESULTS AND DISCUSSION

Summer 2005

Soil Chemistry

The mean soil salinity ranged from 11.65 ppt at the 30-m transects to 18.51 ppt at the 9-m transects during the summer survey (Table 12 and Figure 14). All mean soil pH values for the Summer 2005 survey are slightly alkaline and exhibit a linear increase, from the 3- through 9-m transects, with a range of 7.42 ppt to 7.65 ppt (Table 12 and Figure 15). The 18- and 30-m transects decrease from 7.63 to the lowest overall value of 7.36, respectively, for this survey.

Vegetation

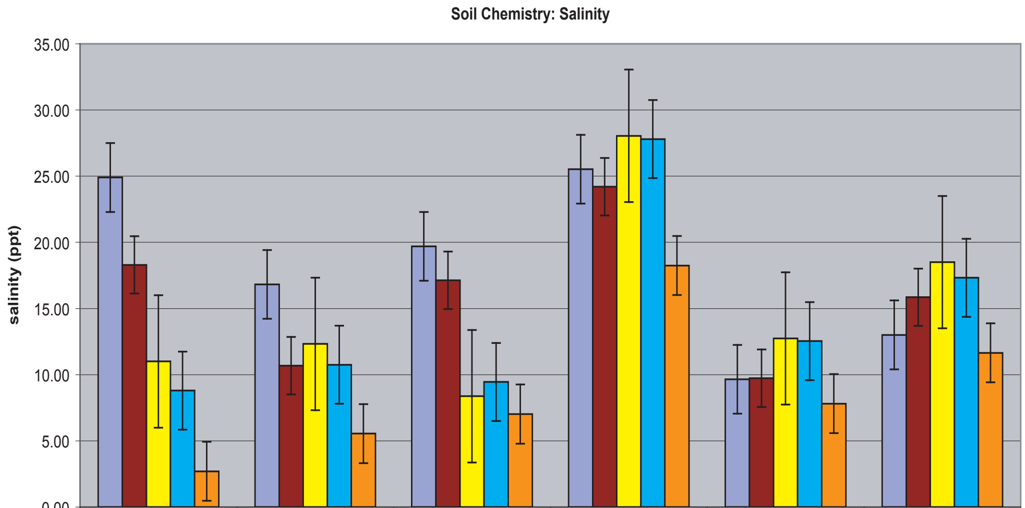
The combined mean percent cover for the nine plant species encountered is greatest in the 3-m transect pair (80.2%), intermediate at 9- and 5-m (64.1% and 61.8%, respectively), less at 18-m (48.5%), and least at 30-m (37.8%, Figure 16). In fact, with the exception of the 5-m transect, vegetative percent cover diminishes with distance from channel.

The mean percent cover of *Salicornia virginica* was greatest in the 18-m transect pair, followed by the 5-m transect pair (Figure 17). The 3-m pair was primarily composed of *Jaumea carnosa* (fleshy Jaumea) and very similar to the 9-m transect pair in *S. virginica*. The 5-m pair was dominated in relatively equal percentages by these two species. The native *Atriplex triangularis* (spear oracle) did not occur in the 3-m transect pair, as it did in Fall 2003; however, it did occur in all other station pairs with relatively low percent coverage.

Mean canopy height of all species was greatest in the 18-m transect pair (54.1 cm), followed by the 5- and 9-m pairs (each 48.1 cm), 30-m (41.8 cm), and least in the 3-m pair (Figure 18).

Comparison of Summer 2005 Replicates (Transect Pairs)

The 3-m transects (2 and 5) were fairly similar in species composition and abundances. Transect 2 contained only two species, *J. carnosa* and *S. virginica*, with the former dominating the composition (36.6% of total quadrat mean). Transect 5 also was dominated by *J. carnosa* (58.0%) followed by *S. virginica* (12.2%), but differed in that it also contained *Atriplex triangularis*, *Cressa truxillensis*, and *Distichlis spicata*. Mean canopy height for this pair was greatest in Transect 5 (42.5 cm). The mean height for Transect 2 was markedly lower with 32.8 cm. Soil pH changed only slightly between these transects and among equidistant pairs to the magnitude hundredths of a pH unit. Soil salinity was greatest in Transect 5 with 14.78 ppt followed by 11.22 ppt in Transect 2.



	Spring 2001	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Summer 2005
3 m	24.90	16.83	19.70	25.53	9.65	13.01
5 m	18.30	10.68	17.14	24.20	9.74	15.85
9 m	11.00	12.33	8.37	28.05	12.74	18.51
18 m	8.80	10.75	9.46	27.80	12.54	17.33
30 m	2.70	5.55	7.02	18.25	7.81	11.65

Sampling Event

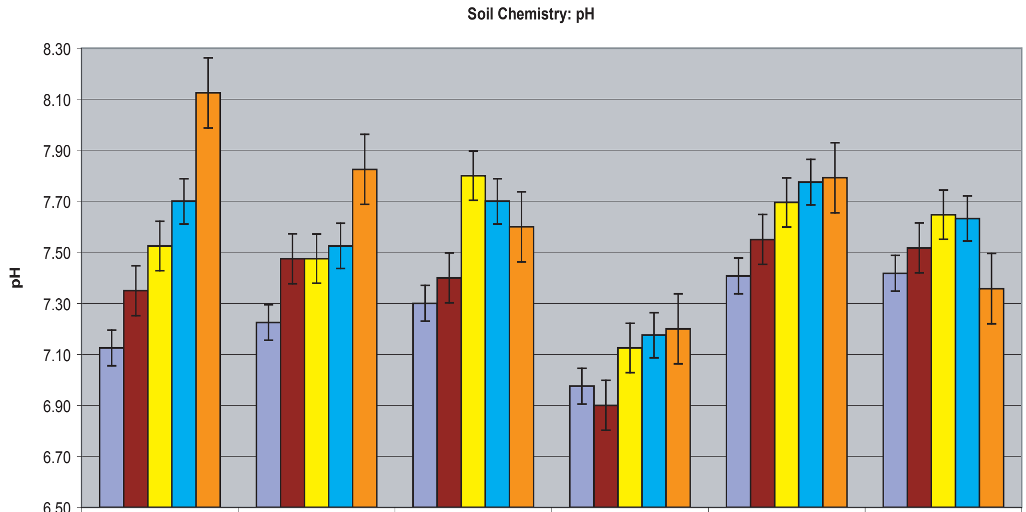
Figure 14. Soil salinity in Ballona Wetlands since 2001.

The 5-m transects (1 and 6) differed in species richness during this survey as Transect 1 had only two species while Transect 6 had four. Of the mean quadrat surface areas, Transect 1 had a mean percent cover of 63.16 and Transect 6 had 60.50. Of the vegetated cover, *J. carnosa* constituted 78.36% and 29.75%, *S. virginica* had 21.64% and 50.96%, and *C. truxillensis* had 0% and 18.46%, in Transects 1 and 6, respectively. The mean canopy height, soil pH and soil salinity were noticeably higher in Transect 6 (52.7 cm, pH 7.66, 18.86 ppt) than Transect 1 (43.5 cm, pH 7.37, 12.84 ppt).

Although their species richness were similar, the 9-m transects (3 and 7) were quite different in relative abundances and composition. Transect 3 had mean percent vegetative cover of 79.17 while Transect 7 had 49.00. Of the mean percent cover, Transect 3 was co-dominated by *Salicornia virginica*, *J. carnosa*, and *A. triangularis* with 33.68%, 32.63%, and 31.58%, respectively. Transect 7 varied dramatically in that it was primarily dominated by *C. truxillensis* (74.83%) followed by *J. carnosa* (21.77%) and *S. virginica* (3.40%). Canopy height and salinity were markedly higher in Transect 3 (60.17 cm and 21.57 ppt) compared to Transect 7 (36.00 cm and 15.44 ppt). Transect 3 was lower in pH with 7.46 compared to 7.83 in Transect 7.

The 18-m transect pair (4 and 8) showed a marked difference in percent vegetative cover with 60.17 and 36.83, respectively. In decreasing order of the total vegetative percent cover, *S. virginica* (72.02%), *Atriplex triangularis* (19.67%), *J. carnosa* (6.92%), and *Myoporum laetus* (1.38%) accounted for the diversity of Transect 4, while *S. virginica* (79.18%) and *C. truxillensis* (20.81%) did so for Transect 8. The transect pair was fairly similar in canopy height with 58.67 cm and 50.33 cm, in Transects 4 and 8 respectively. Salinities were similar with 18.03 ppt and 16.62 ppt in Transects 4 and 8, respectively. Soil was similarly alkaline with 7.57 and 7.69.

The 30-m transects (9 and 10) were different in percent vegetative cover with 28.33%



	Sp 2001	Sp 2003	Fall 2003	Sp 2004	Fall 2004	Summer 2005
3 m	7.13	7.23	7.30	6.98	7.41	7.42
5 m	7.35	7.48	7.40	6.90	7.55	7.52
9 m	7.53	7.48	7.80	7.13	7.70	7.65
18 m	7.70	7.53	7.70	7.18	7.78	7.63
30 m	8.13	7.83	7.60	7.20	7.79	7.36

Figure 15. Soil pH in Ballona Wetlands since 2001.

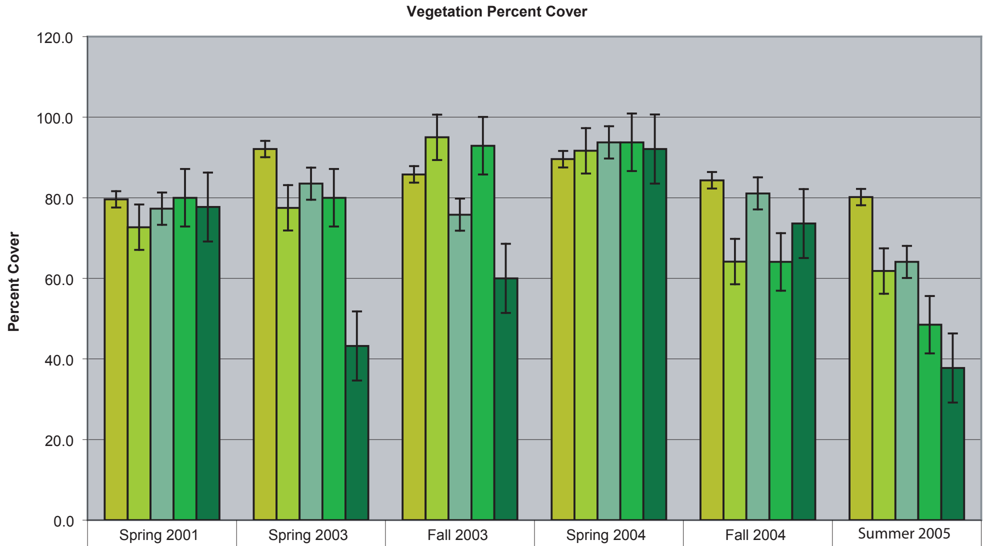
and 47.17%, respectively. Those species contributing to that of Transect 9 were *S. virginica* (58.82%), *S. subterminalis* (26.47%), *C. truxillensis* (11.76%), and *Frankenia salina* (2.94%), in decreasing order of the total vegetative percent cover. Transect 10 was composed of *J. carnosa* (38.87%), *S. virginica* (36.04%), *C. truxillensis* (16.25%), and the slender marsh aster*, Aster subulatus* var. *ligulatus* (8.83%), in decreasing order of percentages. Salinity was 9.86 ppt and 13.44 ppt, pH was 7.12 and 7.59, while there was a marked difference in canopy height with 29.33 cm and 54.17 cm in Transects 9 and 10, respectively.

Comparison of Summer 2005 with Fall 2004

Mean salinity values are higher in all transect pairs compared to Fall 2004 (Figure 14), while mean pH values are slightly lower in all transect pairs, except the 3-m (Figure 15).

Although the same number of species (nine) were observed in the 60 quadrat/ 10 transect collective for summer 2005 as were for Fall 2004, there were slight differences in type. Of these nine species, only *Myoporum laetum* (myoporum) is non-native and was represented by a single occurrence (quadrat 5, Transect 4), a reduction in non-native species from Fall 2004 when three were observed. This most recent survey showed the first appearance of the native *Aster subulatus var. ligulatus* (slender marsh aster) within any sampling event transect. *Jaumea carnosa*, *A. triangularis*, *S. virginica*, *C. truxillensis var. vallicola*, and *D. spicata* remain to be constants in each survey since the beginning of the Project. Again, *S. subterminalis* was observed proximal to several quadrats.

Due to this seasonal premier summer survey, many senesced annual grass understory remnants were observed in many quadrats of several transects. Because of their condition, they were unable to be definitively identified. It is likely, based on their presence in previous surveys and gestault morphology, that these may have included two other non-natives, *Parapholis incurva* (curved sickle grass) and



	Spring 2001	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Summer 2005
3 m	79.6	92.1	85.8	89.6	84.3	80.2
5 m	72.7	77.5	95.0	91.7	64.2	61.8
9 m	77.3	83.5	75.8	93.8	81.1	64.1
18 m	80.0	80.0	92.9	93.8	64.1	48.5
30 m	77.7	43.2	60.0	92.1	73.6	37.8

Sampling Event

Figure 16. Overall vegetation percent cover in Ballona Wetlands since 2001.

Avena sp. (wild oat).

Gross vegetation percent cover is very similar to Fall 2004 in the 3- and 5-m transects. Departure from values acquired in Fall 2004 occurs serially, starting from the 9-m transects and maximizes in the 30-m transects, with the greatest difference in value (35.8%). Canopy heights are similar to Fall 2004 for the 5-, 18-, and 30-m transects, but differ noticably for the 9-m and less so for the 3-m transects.

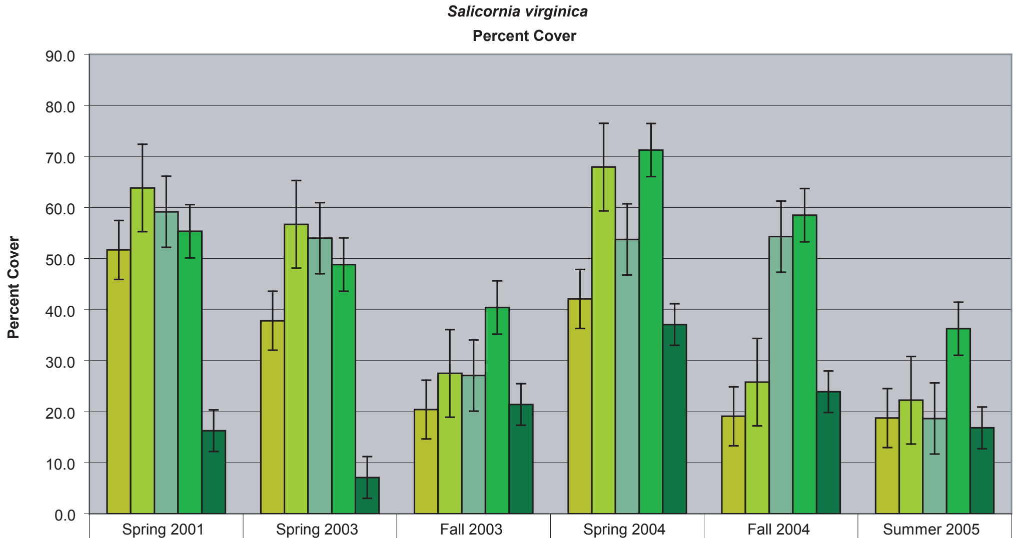
Comparisons Among Surveys to Date

Collectively, the Summer 2005 mean soil salinity values are noticeably higher, but yet maintain the same relative graphical shape among transects as in Fall 2004 (Figure 14). Since the Spring 2004 survey, the 9-m transects, closely followed by the 18-m transects, have shown the highest values of each respective survey. The Summer 2005 pH values are similar in being somewhat moderate relative to other sampling events (Figure 15). Noticeable differences include the generally low values in Spring 2004 across the spectrum and the highest value recorded for the Spring 2001 30-m transect pair.

Vegetation percent cover in Summer 2005 was generally lower in every transect pair compared to earlier sampling events, with the exception of the Spring 2001 3-m pair (Figure

Table 13. Vegetation occurrence in Ballona Wetlands since 2001.

	spring 2001	spring 2003	fall 2003	spring 2004	fall 2004	summer 2005
Mesembryanthemum crystallinum		■	■	■		
Aster subulatus var ligulatus						■
Jaumea carnosa	■	■	■	■	■	■
Sonchus asper ssp. asper	■	■	■			
Sonchus oleraceus				■		
unknown aster		■	■	■		
Atriplex semibaccata					■	
Atriplex triangularis	■	■	■	■	■	■
Salicornia subterminalis					■	■
Salicornia virginica	■	■	■	■	■	■
Cressa truxillensis var. vallicola	■	■	■	■	■	■
Melilotus indica		■	■			
Frankenia salina	■	■	■	■		■
Myoporum laetum						■
Avena barbata	■					
Avena sp.				■		
Bromus madritensis ssp. *rubens*				■	■	
Distichlis spicata	■	■	■	■	■	■
Lolium sp.				■		
Parapholis incurva	■	■	■	■		
Polypogon monspeliensis	■	■	■	■	■	
Polygonum lapathifolium	■					
unknown shrub	■					
Total number of species	12	12	12	14	9	9



	Spring 2001	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Summer 2005
3 m	51.7	37.8	20.4	42.1	19.1	18.75
5 m	63.8	56.7	27.5	67.9	25.8	22.25
9 m	59.2	54.0	27.1	53.8	54.3	18.67
18 m	55.4	48.8	40.4	71.3	58.5	36.25
30 m	16.3	7.1	21.4	37.1	23.9	16.83

Sampling Event

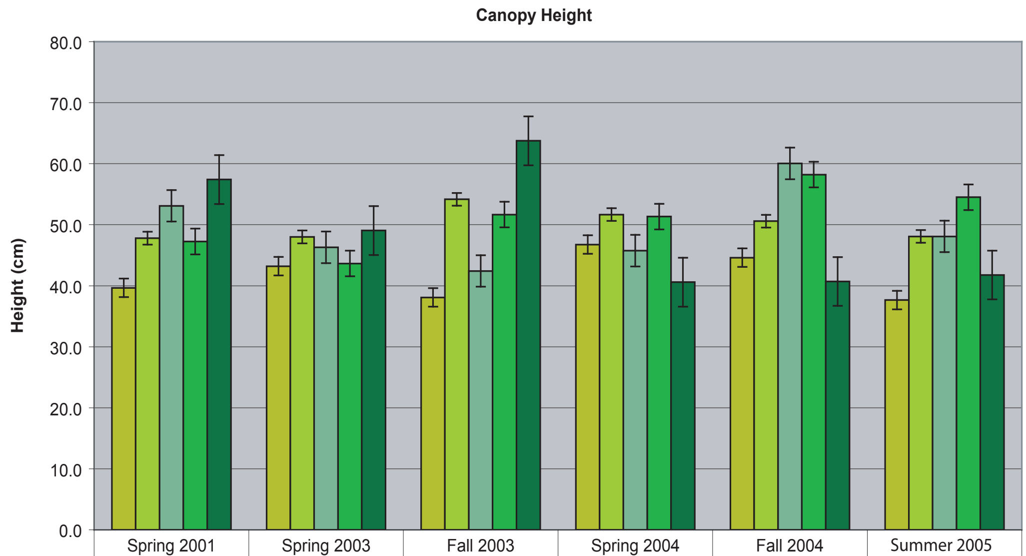
Figure 17. *Salicornia virginica* percent cover in Ballona Wetlands since 2001.

16). *Salicornia virginica* percent cover was also lower in Summer 2005 than in earlier sampling events, with the exception of the 30-m transects in Spring 2001 and Spring 2003 (Figure 17).

The slight reduction in *S. virginica* cover at the 3-m, 5-m, and most dramatically in the 9-m transects may well be what is expected considering the current transitional 1.1-m MLLW inundation increase, the steepness or near-vertical banking of the channel morphology, the straddling and breaching the tidal water imposes on the banks during high tides, and the subsequent spatial, lateral expansion of the water resulting from this situation. It has been shown that increased tidal inundation, as little as 8 cm, plays a major role in the reduction of growth, as much as 30-40%, in seedlings and older *S. virginica* (Mahall and Park 1976). The 18-m and 30-m transects also showed a reduction, but to a lesser extent compared to the 9-m pair, especially the latter. No explanation is offered for this decrease in the 18-m transect. However, all transects were likely exhibiting the seasonal growth retardation that *S. virginica* undergoes in late summer and fall (Zedler 1982) and may account for the entirety of the 7.1% loss in the 30-m transects from Fall 2004 to Summer 2005. Ultimately, we expect an expansion of *S. virginica* cover, height, and hence, suitable BSS habitat, will occur following the increase to 1.2 m inundation scheduled for September 2006. This is expected to occur at various locations, especially those juxtaposed to the terminus of east spur of the main channel. Due to original transect placement, however, only Transects 7 and 8 are in locations having potential to reflect such changes.

Superficially, all canopy height values have been somewhat similar since the beginning of the Project (Figure 18). The most noticeable value elevations, relative to other sampling events, occurred in the 9- and 18-m transects during the Fall 2004 survey and more so in the 30-m pairs of Spring 2001 and Fall 2003.

Because this was the first Ballona Wetlands 1135 Restoration Project survey to describe



	Spring 2001	Spring 2003	Fall 2003	Spring 2004	Fall 2004	Summer 2005
3 m	39.7	43.2	38.1	46.8	44.6	37.7
5 m	47.8	48.0	54.2	51.7	50.6	48.1
9 m	53.1	46.3	42.4	45.8	60.0	48.1
18 m	47.3	43.7	51.7	51.3	58.2	54.5
30 m	57.4	49.1	63.8	40.6	40.7	41.8

Sampling Event

Figure 18. Overall vegetation canopy height in Ballona Wetlands since 2001.

summer vegetation and soil chemistry, comparison with other sampling events is limited. It does begin, however, to show the seasonal fluctuations, serve as a foundation to compare future summer surveys, and function as a baseline for the forthcoming inundation increase from 1.1-m to 1.2-m MLLW in September 2006. Disregarding this caveat, comparison of Summer 2005 with Fall 2004 shows a marked decrease of *S. virginica* percent cover in every transect pair. Furthermore, comparing species diversity among all surveys shows stasis in the first three surveys, elevation to 14 in spring of 2004, and a decline to nine in the most recent two (Table 13). Species occurrence has fluctuated somewhat among surveys, but with *J. carnosa*, *A. triangularis*, *S. virginica*, *C. truxillensis*, and *D. spicata* remaining constant dominants.

Comparing Fall 2004 with Spring 2004, one can see the obvious decrease in *S. virginica* abundance indicated by percent cover. Comparisons of unlike seasons may lead to erroneous conclusions and causality. For example, there is an obvious decrease in *S. virginica* abundance from Spring 2004 to Fall 2004 as the plants moved into their late summer drought-induced dormancy. However, comparing like seasons as in Fall 2004 and Fall 2003 shows a dramatic increase in percent cover. The implications of seasonality should not be overshadowed by mis-comparisons of unlike seasons.

SUMMARY

Fewer non-native species were observed during the 2005 survey, likely not due to an actual reduction of non-natives, but rather the change in sampling season. Furthermore, close inspection of previous surveys that had higher non-native richness reveal low incidence and abundance, at least by a few species. Evidence of unidentifiable erect but desiccated grasses not included, as well as abundant “leaf” litter in the channel-distant transects, offers likelihood of they being non-native considering survey history. However, we believe that the change to 1.2 m inundation will aid in reducing the non-native plants as a result of increased salinity, particularly at the 30-m transects.

Most of the differences in percent cover and diversity between transects, equidistant from their nearest channel, or pairs (replicates), are largely due to the inherent patchiness, or spatial heterogeneity, of plants in general. Additionally, subtle differences in elevation between transects may account for hydrological, and hence soil chemistry, variability that determines the presence, absence, or abundance of a given species or species set. Albeit, replication due to original placement of transects and data collection practices throughout all surveys appears to have been achieved.

Due to Water Year (WY) 2004-2005 being the wettest on record since WY 1883-1884, rainfall probably promoted the increase of vegetation percent cover and canopy height, but yet also served to confound interpretation. Had there been a previous summer survey in any year since project inception, it would have allowed for a clearer seasonal comparison of these metrics, and thus, illuminated late summer growth reduction.

Given the high rainfall for 2005, precipitation probably influenced the results of the salinity and pH values as well, which are often reflected soon in plant distribution and condition. Most tidal wetlands are close to neutral pH but can vary as much as two units within a tidal cycle due to water infiltration (i.e., rain) and benthic biological activity (Zedler 2001 and references therein). Soil salinity changes daily in the high marsh in response to extreme high tides, rainfall, and evaporation (Zedler 2001). In Marisma de Nación in San Diego Bay, salinity of surface material was >80 ppt prior to introduction of tidal water (Zedler 2001).

Given the season of this most recent survey, it follows that soil salinities have increased from those measured in the fall of 2004 for all transect pairs, simply resulting from temporal remoteness of freshwater input and increased evaporation. Furthermore, within a given tidal wetland and excluding interannual and seasonal rainfall variability assumptions, soil salinities should increase proportionally to distance from inundation and at higher elevations as regularity of inundation proceeds (Zedler 2001). This is largely due to increased evaporation in these areas which are seasonally amplified.

Once inundation is increased to 1.2 m, bringing a more natural tidal regime to the Wetlands, we expect that the vegetative cover of the pickleweed alliance will expand. Increased soil salinities will discourage non-native plants and grasses, effectively reducing competition, from these non-native species, to allow native plants to flourish. This will provide better habitat for the endangered Belding's savannah sparrow and other fauna.

BIRDS

Focused Surveys for
Belding's Savannah Sparrow at the Ballona Wetlands, 2005

(modified from original format by CLAEMD)

prepared by

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September 23, 2005

INTRODUCTION

This report summarizes the findings of five surveys conducted in April through June 2005 by Keane Biological Consulting (KBC) for the Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*) at the Ballona Wetlands Study Area (Study Area) as part of the Ballona 1135 Restoration Project. KBC had conducted surveys for the Belding's Savannah Sparrow (hereafter BSS) in 2001 and 2004 for the U.S. Army Corps of Engineers, Los Angeles District (Corps), through their contract with MEC Analytical Systems, Inc. – Weston Solutions. The 2001 surveys were conducted prior to the restoration project, and the 2004 surveys were conducted following the restoration project, which was conducted in spring 2003, with construction monitored by Russell Ruffing, Environmental Supervisor I, City of Los Angeles, Bureau of Engineering.

The goal of the 2001, 2004 and 2005 BSS surveys was to determine the number of BSS breeding pairs and territories in the Study Area. Results of 2004 surveys were compared with those of 2001 to ascertain whether the 1135 Restoration Project was successful in enhancing habitat for BSS. Numbers of BSS territories were similar during 2001 and 2004 surveys. However, because habitat changes in the Study Area are likely continuing with the enhanced tidal influence rendered by the BRP, the Corps requested an additional year of post-restoration surveys be conducted by KBC through the City of Los Angeles Environmental Monitoring Division, under Ann Dalkey.

The Ballona 1135 Restoration Project (BRP) was implemented by the Corps in spring 2003 and included improvement of tidegates between the Ballona Creek Channel and the Ballona Wetlands to improve tidal flushing. The BSS is listed as endangered under the California Endangered Species Act since 1974, is known to nest in the Study Area, in clumps of pickleweed (*Salicornia* sp.) approximately one foot in height. Because improved tidal flushing in the Study Area may beneficially affect the extent and health of pickleweed, a common plant of coastal saltmarshes in California, the Corps was interested in concomitant effects of the BRP on the BSS population in the Study Area.

The Study Area is located in Marina del Rey, California, and is bordered on the north by the Ballona Creek channel, on the south by the Southern California Gas facility and adjacent bluff, on the west by the community of Playa del Rey and on the east by the Southern California Gas Company access road south of Culver Boulevard and on the north by Culver Boulevard as it curves northeast (Figure 19).

Figure 19. Location of Study Area for Belding's Savannah Sparrow Surveys, 2005.

METHODS

Species Background

The savannah sparrow is a widespread and abundant species of North American open habitats south to northern El Salvador and Honduras. Seventeen subspecies are recognized, most of which are migratory, although several subspecies are year-round residents of coastal salt marshes. These include the large-billed savannah sparrow (*Passerculus sandwichensis rostratus*), which occurs along the east and west shores of the Gulf of California, and the BSS, which is found from Goleta Slough in Santa Barbara County to El Rosario, Baja California. The BSS is 5.5 inches long and is similar to other subspecies of savannah sparrows but is darker and heavily streaked on the back, breast, and sides (Wheelwright and Rising 1993).

A partial statewide survey for BSS was conducted in 1973, and the first statewide survey was made in 1977. Since 1986, statewide surveys have been undertaken at five-year intervals. The latest statewide count was coordinated by USFWS in 2001, and 2,902 breeding pairs were counted, up 23.5% from the 1996 count of 2,350 pairs. with the largest population at Mugu Lagoon (809), followed by Seal Beach Wildlife Refuge (293), Tijuana Marsh (289) and Upper Newport Bay (206). In addition, more than 100 pairs were counted at Bolsa Chica wetlands, the Santa Margarita River estuary, Western Salt Co. dikes and Los Penasquitos Lagoon (Zembal and Hoffman 2002).

The statewide population appears to be stabilized although fluctuating greatly in total numbers and in local breeding population size. The number of habitat sites supporting breeding pairs has slowly declined since

Figure 20. Map of Survey Route for 2005 Belding's Savannah Sparrow Surveys.

the 1970s. Since surveys began, five BSS subpopulations have disappeared. The only new population forming in the 1990s was at Newport Slough, site of a marsh restoration project by the Corps at the mouth of the Santa Ana River (CDFG 2000).

Savannah sparrows of other subspecies have likely benefited from human activity because of their preference for breeding in open habitats such as agricultural fields and grazing lands (Wheelwright and Rising 1993). However, the BSS population has declined over the past century due to destruction of suitable salt marsh habitat by filling for housing, industrial use and marina development (Garrett and Dunn 1981). Other factors affecting the population decline include loss of regular tidal connection with the ocean and inconsistent tidal influence on upper marsh habitat, disruptions in the natural drainage of coastal wetlands because of upstream development or flood control, human disturbance and exotic predators in marshes, especially feral and domestic cats and non-native red foxes (*Vulpes vulpes*). However, recent habitat protection and enhancement projects, such as those at Batiquitos Lagoon and the mouth of the Santa Ana River, have resulted in improvements in habitat conditions (CDFG 2000).

Habitat occupied by BSS is dominated by pickleweed, sea-blite (*Suaeda* sp.), salt bush (*Atriplex* sp.), and salt grass. Although other subspecies subsist on a diet of insects during the summer and seeds during the winter, BSS eat a variety of crustaceans as well as seeds of pickleweed. They may forage in other nearby habitats including along rock jetties (Garrett and Dunn 1981) and are capable of drinking salt water. Nests are built low in pickleweed in middle to upper portions of salt marshes, or in non-tidal seepage areas dominated by

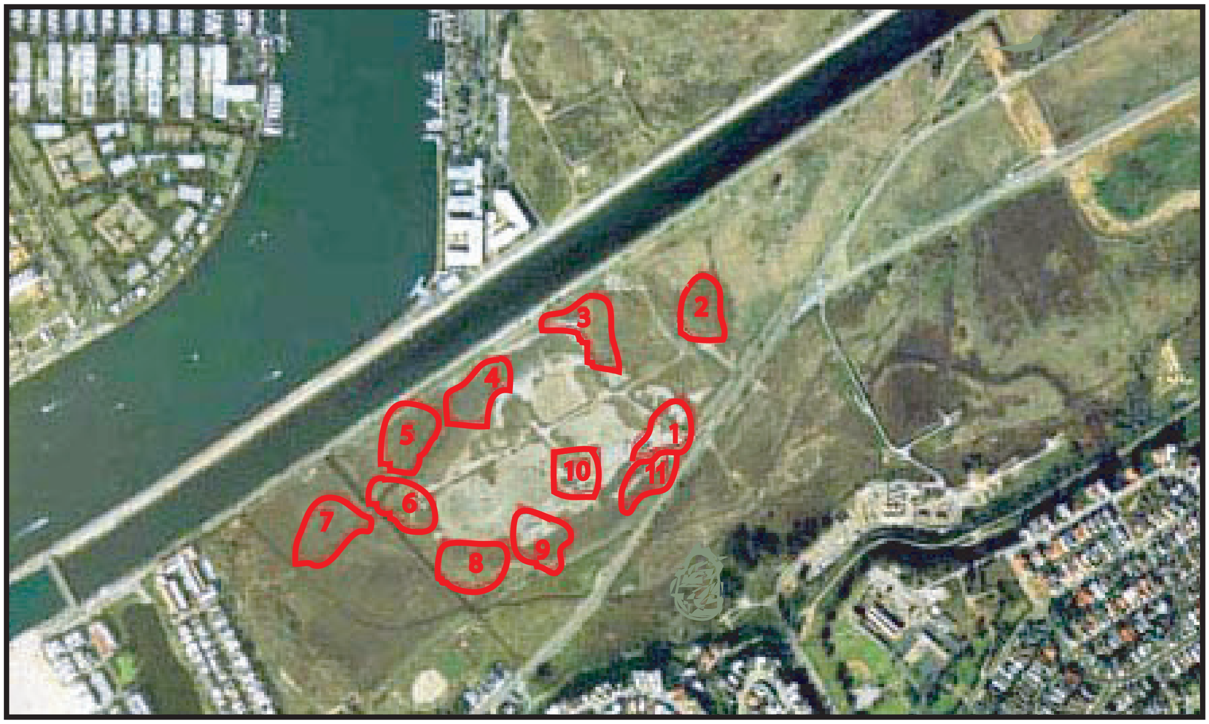

Figure 21. Approximate locations and boundaries of Belding's Savannah Sparrow territories, 2005.

pickleweed (Massey 1977). In addition to cats and red foxes, predators include several raptor species, clapper rail (*Rallus longirostris levipes*), striped skunk (*Mephites mephites*) and raccoon (*Procyon lotor*) (Wheelwright and Rising 1993).

Survey Methods

The entire Study Area was surveyed by Kathy Keane of KBC, with emphasis placed on the area around the main and west channels, on April 15, April 23 and May 14, 2005 (spring surveys) and June 9 and June 16 (summer surveys). Surveys were initiated between 0600 and 0700 and concluded by 1000. The primary purpose for the spring surveys was to determine the approximate number of BSS territories in the Study Area, while the summer surveys focused on estimating productivity determined by censusing the number of BSS juveniles.

Field notes were maintained during each survey and included notes on BSS behavior and other bird species observed (see Appendix C). In addition, the survey route was drawn on an aerial photograph of the Study Area during each survey (Figure 20) and ensured that all areas of tidal and non-tidal saltmarsh habitat dominated by pickleweed were visited. The direction of the survey route, and the order in which portions of the Study Area were surveyed (e.g., north and south of Culver Boulevard, and north of Culver Boulevard but west of the main channel), varied among survey dates so that portions of the Study Area were visited at different times of day. This ensured that BSS territory holders more active at a particular time of the morning were not missed.

Spring survey methods followed those used during statewide censuses for this species, as summarized in Zembal et al. (1988). Methods entail walking slowly and stopping adjacent to all areas of suitable habitat and watching and listening for singing males and other breeding behavior (feeding young, carrying nesting material) to determine the

Figure 22. Approximate locations of Belding's Savannah Sparrow family groups, 2005.

number of breeding pairs or territories. When a bird carrying nesting material or food for young was noted, the observation continued until the approximate location of a nest was observed. Sightings of singing males, non-singing individuals or pairs, individuals carrying nesting material, and other pertinent observations were recorded on an aerial photograph of the Study Area. The survey route (Figure 20) was varied among surveys so that portions of the Study Area were visited at different times each survey. For example, the western portion of the Study Area was surveyed first on some surveys, while other surveys began with the eastern portion. In addition, the routes were sometimes walked clockwise, and other times counter-clockwise.

Methods for the summer surveys were similar to spring survey methods and entailed walking slowly and stopping adjacent to all areas of suitable BSS habitat. However, rather than searching for singing male BSS to census the approximate number of BSS territories, the summer surveys focused on estimating reproductive success by searching for BSS family groups (3 or more birds). The presence of a family group within a territory indicates that the BSS pair on that territory was successful that year at fledging (raising to flight stage) one or more young. Locations of sightings were recorded on the aerial photograph of the Study Area.

RESULTS

Spring Surveys

Based on observations of singing BSS males and other observations during the three spring surveys April 15, April 23 and May 14, 2005, approximately 11 BSS territories were present in the Study Area during spring 2005 surveys (Figure 21). No BSS were present south of Culver Boulevard.

Summer Surveys

Only one family group, FG-1 (Figure 22)

Table 14. Results of Surveys for Belding's Savannah Sparrow at Playa Vista, 1977 to 2005.

YEAR	#of TERRITORIES	SURVEYS CONDUCTED BY
1977	37 pairs	Massey 1977
1979	21	Dock and Schreiber 1981
1980	18	Dock and Schreiber 1981
1981	13	Dock and Schreiber 1981
1982-1985	No data	--
1986	32	Zembal et al. 1988
1987	30	Massey 1987
1988	No data	--
1989	31	White and White 1989
1990	11-12	Corey and Massey 1990
1991	1 to 30 throughout the year	Corey 1991
1992-1993	No data	--
1994	10	Lockhart 1994
1995	21	Keane Biological Consulting 1996
1996	37[a]	John Konecny, USFWS
1997	No surveys	No surveys
1998	12 to 13	Keane Biological Consulting 1998
2001	13 to 15	Keane Biological Consulting 2001
2003	No estimate—construction monitoring only	Observations during tide gate construction by Russell Ruffing, City of Los Angeles
2004	12	Keane Biological Consulting 2004
2005	11	This study—Keane Biological Consulting

[a] this is likely an overestimate—see conclusions and recommendations

was observed during both June 9 and June 16 surveys. It included three to four birds, although it was difficult to determine the size of the group as the male of this group was involved with territorial altercations with a male from an adjacent territory. FG-2 (Figure 23) was observed during the last spring survey May 14 and also included three birds; this observation was included as territory #4 (see Figure 22 herein and Figure 2, spring survey report dated June 17, 2005; it was not observed during the June surveys. Thus, it is possible that FG-2 and FG-1 are the same family group that moved west following the May 14 observation. No other family groups were observed during the summer (June) or spring (April-May) surveys; however, because of the extensive rains during the winter of 2004-2005 and relatively cool weather in May and June, it is possible the BSS breeding season may extend into late June or early July, resulting in additional family groups.

Comparison with Previous Surveys

Focused surveys for BSS were conducted from the late 1970's through the present, and BSS have been observed in the Study Area during all surveys (Table 14). Comparison among recent surveys suggests that the BSS population in the Study Area has been fairly stable since 1998, although one less territory was present during 2005 surveys than during 2004 surveys, and two to four fewer territories were estimated for 2005 as compared with the 2001 surveys. However, observations in 2005 included more activity and flights of BSS from one location to another, indicating that BSS territories are often far larger than one would estimate without spending considerable effort watching the movements of individual BSS. Thus, it is possible that territory numbers did not actually decline from 1998 to 2005 but that some territories identified during previous surveys represented extensions of other territories.

Similar to previous surveys, no BSS territories were detected in areas south of Culver Boulevard during the 2005 surveys. Some groundwater is present in this area that continues to nourish pickleweed, which includes areas without heavy growth of non-native species, but pickleweed is dense and lacks tidal influence. In addition, the area south of Culver lacks the berm that is present between Culver Boulevard and wetlands to the north, where the BSS population is located. This berm likely serves as a sound buffer for traffic noise, allowing BSS to communicate more effectively among individuals than they could south of Culver Boulevard.

CONCLUSION AND RECOMMENDATIONS

The BSS population at the Ballona Wetlands was fairly stable from 1998 through 2005. However, red foxes are still present, and some areas appear to be converting from the pickleweed species apparently more preferred by BSS (*Salicornia virginica*) to the species typically found in higher marsh elevations (*Salicornia subterminalis*) and/or other higher-marsh species including alkali weed (*Cressa truxilensis*) and jaumea (*Jaumea carnosa*). In addition, large portions of the Study Area remain dominated by non-native grasses, mustards, and ice plant.

Saltmarsh restoration projects that would replace non-native vegetation with pickleweed would enhance habitat value for BSS, as would management of the red fox population. Increased tidal inundation, as proposed by the Corps, is also expected to enhance habitat value for BSS by eliminating some types of non-native vegetation that are not salt-tolerant and by creating, due to increased tidal influence, suitable conditions for expansion of pickleweed into areas that are now barren saltflats. However, because BSS nests are generally on the ground or a few inches above the ground, and because much of the pickleweed currently inhabited by BSS is less than 10 inches tall, some areas now suitable for BSS may be rendered unsuitable with increased tidal inundation. Thus, following an increase in tidal inundation due to proposed tidegate modification, a temporary loss of occupied BSS may likely occur until pickleweed can grow taller and/or expand into new areas.

Another increase in tidal fluctuation is planned for fall 2005, and focused BSS surveys should continue for two to three years following the inundation to document changes in the number of BSS territories between spring 2005 surveys and surveys conducted subsequent to the inundation increase.

Additional observations of biological interest other than those of the Bird Survey are presented in Appendix D.

APPENDIX A:

Benthic Macrofauna Occurring in Ballona Wetlands, 2005

Benthic Macrofauna Occurrence and Abundance in ballona Wetlands, 2005

Taxa \ Station (Replicate)	BWB1 (1)	BWB1 (2)	BWB1 (3)	BWB2 (1)	BWB2 (2)	BWB2 (3)	BWB3 (1)	BWB3 (2)	BWB3 (3)	BWB4 (1)	BWB4 (2)	BWB4 (3)	BWB5 (1)	BWB5 (2)	BWB5 (3)	BWB6 (1)	BWB6 (2)	BWB6 (3)	BWB7 (1)	BWB7 (2)	BWB7 (3)	BWB8 (1)	BWB8 (2)	BWB8 (3)	Abundance	Occurrence
Oligochaeta	14	44	76	12	135	49	70	238	26	1	2	2	4	61	16	36	4	56	140	27	39	143	48	223	**1466**	**24**
Capitella capitata Cmplx			1		53	26	1	46			6	1	3	25	2	281	1	69	76	127	112	38	39	110	**1017**	**19**
Grandidierella japonica	34	7	49	26	55	67	2	37	24	21	22	27		7		3	5	25				1		3	**415**	**18**
Notomastus sp HYP3								20																	**20**	**1**
Streblospio benedicti		26	8		33	18	2	11	3	1			2	123	6	1			2						**236**	**13**
Protothaca staminea							12	5	3																**20**	**3**
Polydora nuchalis			2	2		2	20	3	1	1				2	4	126	20	75	27	15	14	25	18	81	**438**	**18**
Paranemertes californica	1	1	1					3	1																**7**	**5**
Polydora sp								3																	**3**	**1**
Monocorophium insidiosum		4	13	31	44	87		2	2	17	5	12	1	12	19	43	18	122	3			42	6	18	**501**	**20**
Ampithoe valida					7	14		1	1	9	3	7		2		14		3							**61**	**10**
Mytilus californianus								1																	**1**	**1**
Palaeonemertea								1																	**1**	**1**
Notomastus hemipodus	3						13		5																**21**	**3**
Monocelididae									2																**2**	**1**
Acteocina inculta	1	1	7			7	1		1	1		1		2	1	1	1	1		1	1	1	1		**30**	**17**
Venerupis philippinarum							1		1																**2**	**2**
Anthopleura artemisia									1																**1**	**1**
Macoma nasuta									1																**1**	**1**
Sipuncula							2																		**2**	**1**
Theora lubrica							2																		**2**	**1**
Hemipodus borealis		1	2				1																		**4**	**3**
Protothaca laciniata							1																		**1**	**1**
Tagelus affinis							1																		**1**	**1**
Acteocina harpa																					1		1		**2**	**2**
Anthozoa		3			13																	1			**17**	**3**
Campanulariidae			1																						**1**	**1**

Benthic Macrofauna Occurrence and Abundance in ballona Wetlands, 2005(Continued)

Taxa / Station (Replicate)	BWB1 (1)	BWB1 (2)	BWB1 (3)	BWB2 (1)	BWB2 (2)	BWB2 (3)	BWB3 (1)	BWB3 (2)	BWB3 (3)	BWB4 (1)	BWB4 (2)	BWB4 (3)	BWB5 (1)	BWB5 (2)	BWB5 (3)	BWB6 (1)	BWB6 (2)	BWB6 (3)	BWB7 (1)	BWB7 (2)	BWB7 (3)	BWB8 (1)	BWB8 (2)	BWB8 (3)	Abundance	Occurrence
Drillactis sp BW1	3			5		7					1	2	1	36	33	28	27	52				29	3	48	**275**	**14**
Dynamenella dilatata						10				6	1	1				2	2						1		**23**	**7**
Edwardsia sp		1																							**1**	**1**
Edwardsiidae			2																						**2**	**1**
Euclymeninae			1																						**1**	**1**
Exogone sp						1																			**1**	**1**
Fabricinuda limnicola	37																								**37**	**1**
Lineus sp					1																				**1**	**1**
Macoma secta		1																							**1**	**1**
Adula sp BW1																		1							**1**	**1**
Monocorophium acherusicum	1																								**1**	**1**
Nematoda			1																						**1**	**1**
Notomastus sp										1															**1**	**1**
Spionidae		1			3																				**4**	**2**
Tanaopsis cadieni		1																							**1**	**1**
Tellina cadieni	1																								**1**	**1**
Tethygeneia opata					1																				**1**	**1**
Total Abundance/Rep	**95**	**91**	**164**	**76**	**345**	**288**	**129**	**371**	**72**	**58**	**40**	**53**	**11**	**270**	**81**	**535**	**78**	**404**	**248**	**170**	**167**	**280**	**117**	**483**		
Number of Taxa	**9**	**12**	**13**	**5**	**10**	**11**	**14**	**13**	**14**	**9**	**7**	**8**	**5**	**9**	**7**	**10**	**8**	**9**	**5**	**4**	**5**	**8**	**8**	**6**		

Total Abundance for Survey: 4626

APPENDIX B:

Vegetation Species Occurring in Ballona Wetlands

Plant species observed or known to occur within or adjacent to Ballona Wetlands 1135 Restoration Project study site. Species are ordered initially by family and secondarily by species. Non-native species are indicated by asterisk. Species commonly occurring within transects are indicated in bold. This list is not comprehensive for the greater Ballona Wetlands (Dr. Philippa Drennan, pers. comm.).

Scientific Name	Common Name	Family
Agave sp.*	agave	AGAVACEAE
*Carpobrotus chilensis**	sea-fig	AIZOACEAE
*Carpobrotus edulis**	Hottentot-fig	AIZOACEAE
Mesembryanthemum crystallinum*	**crystalline iceplant**	**AIZOACEAE**
Malosma laurina	laurel sumac	ANACARDIACEAE
Rhus integrifolia	lemonade berry	ANACARDIACEAE
Rhus ovata	sugar bush	ANACARDIACEAE
*Schinus terebinthifolius**	Brazilian pepper tree	ANACARDIACEAE
*Apium graveolens**	celery	APIACEAE
*Foeniculum vulgare**	sweet fennel	APIACEAE
*Phoenix canariensis**	Canary Island date palm	ARECACEAE
Phoenix dactylifera	date palm	ARECACEAE
Washingtonia robusta	Mexican fan palm	ARECACEAE
Ambrosia psilostachya	western ragweed	ASTERACEAE
Artemisia californica	California sagebrush	ASTERACEAE
Artemisia douglasiana	mugwort	ASTERACEAE
Baccharis salicifolia	mulefat	ASTERACEAE
*Centaurea melitensis**	Tocalote	ASTERACEAE
Chaenactis glabriuscula	yellow pincushion	ASTERACEAE
Chrysanthemum coronarium*	**garland daisy**	**ASTERACEAE**
*Conyza bonariensis**	flax-leaved horseweed	ASTERACEAE
Cotula sp.*	brass-buttons	ASTERACEAE
Encelia californica	California bush sunflower	ASTERACEAE
Gnaphalium bicolor	bicolor cudweed	ASTERACEAE
Gnaphalium californicum	California everlasting	ASTERACEAE
Heterotheca grandiflora	telegraph weed	ASTERACEAE
*Hypochaeris glabra**	smooth cat's-ear	ASTERACEAE
Jaumea carnosa	**fleshy Jaumea**	**ASTERACEAE**
*Lactuca serriola**	prickly lettuce	ASTERACEAE
*Lactuca virosa**	wild lettuce	ASTERACEAE
*Picris echioides**	bristly ox-tongue	ASTERACEAE
Sonchus sper* ssp. *asper*	**prickly sow thistle**	**ASTERACEAE**
Stephanomeria sp.	milk aster	ASTERACEAE
unidentified aster (likely *C. coranarium**)	unidentified aster	ASTERACEAE
Xanthium strumarium	cocklebur	ASTERACEAE
Heliotropium curassavicum	salt heliotrope	BORAGINACEAE
*Brassica nigra**	black mustard	BRASSICACEAE
Guillenia lasiophylla	California mustard	BRASSICACEAE
*Raphanaus sativus**	radish	BRASSICACEAE
Atriplex semibaccata*	**Australian saltbush**	**CHENOPODIACEAE**
Atriplex triangularis	**spear oracle**	**CHENOPODIACEAE**
Chenopodium sp.	goosefoot	CHENOPODIACEAE
Salicornia subterminalis	**Parish's pickleweed**	**CHENOPODIACEAE**
Salicornia virginica	**common pickleweed**	**CHENOPODIACEAE**
*Salsola tragus**	Russian thistle	CHENOPODIACEAE
Suaeda sp.	sea-blite	CHENOPODIACEAE
Claystegia macrostegia	western bindweed	CONVOLVULACEAE

Scientific Name	Common Name	Family
*Convolvulus arvensis**	bindweed	CONVOLVULACEAE
Cressa truxillensis	**alkali weed**	**CONVOLVULACEAE**
*Crassula argentea**	jade plant	CRASSSULACEAE
Cuscuta californica	California dodder	CUSCUTACEAE
Carex praegracilis	clustered field sedge	CYPERACEAE
Croton californicus	California croton	EUPHORBIACEAE
*Ricinus communis**	castor-bean	EUPHORBIACEAE
Acacia sp.*	acacia	FABACEAE
Lotus scoparius	deerweed	FABACEAE
Lupinus chamissonis	coastal bush lupine	FABACEAE
*Medicago polymorpha**	bur clover	FABACEAE
Melilotus indica*	**sourclover**	**FABACEAE**
Frankenia salina	**alkali heath**	**FRANKENIACEAE**
*Erodium botrys**	broad-lobbed filaree	GERANICACEAE
Phacelia ramosissima	branching phacelia	HYDROPHYLLACEAE
Juncus bufonius	toad rush	JUNCACEAE
*Malva parviflora**	cheeseweed	MALVACEAE
*Myoporum laetum**	myoporum	MYOPORUM
Abronia villosa	sand verbena	NYCTAGINACEAE
Camissonia bistorta	California sun cup	ONACRACEAE
Camissonia cheiranthifolia	beach evening primrose	ONACRACEAE
Eschsholzia californica	California poppy	PAPAVERACEAE
Plantago lanceolata*	English plantain	PLANTAGINACEAE
Plantago major*	common plantain	PLANTAGINACEAE
Arundo donax*	giant reed	POACEAE
Avena barbata*	slender wild oat	POACEAE
Avena fatua*	wild oat	POACEAE
Bromus diandrus*	ripgut grass	POACEAE
Bromus hordeaceus*	soft chess	POACEAE
Bromus madritensis* spp. *rubens*	**foxtail chess**	**POACEAE**
*Cortaderia jubata**	pampas grass	POACEAE
*Cynodon dactylon**	Bermuda grass	POACEAE
Distichlis spicata	**saltgrass**	**POACEAE**
*Lolium multiflorum**	Italian ryegrass	POACEAE
*Lolium perenne**	perennial ryegrass	POACEAE
Parapholis incurva*	**curved sicklegrass**	**POACEAE**
Polypogon monspeliensis*	**rabbitsfoot grass**	**POACEAE**
*Vulpia myuros**	fescue	POACEAE
Eriogonum fasciculatum	California buckwheat	POLYGONACEAE
Eriogonum parvifolium	dune buckwheat	POLYGONACEAE
*Polygonum arenastrum**	common knotweed	POLYGONACEAE
Polygonum lapathifolium	willow-weed	POLYGONACEAE
Rumex crispus	curly dock	POLYGONACEAE
Rumex salicifolius	willow dock	POLYGONACEAE
Anagallis arvensis	scarlet pimpernel	PRIMULACEAE
Populus fremontii	Fremont's cottonwood	SALICACEAE
Salix laevigata	red willow	SALICACEAE
Salix lasiolepis	arroyo willow	SALICACEAE
Datura wrightii	jimson weed	SOLANACEAE
Lycium califorrnicum	box thorn	SOLANACEAE
Nicotiana glauca	tree tobacco	SOLANACEAE
Solanum douglasii	Douglas' nightshade	SOLANACEAE
Tropaeolum majus	garden nasturtium	TROPAEOLACEAE
Typha latifolia	broad-leaved cattail	TYPHACEAE

APPENDIX C:

List of Birds Observed, Belding's Savannah Sparrow Surveys, 2005

LIST OF BIRDS OBSERVED, BELDING'S SAVANNAH SPARROW SURVEYS, 2005

Family Pelecanidae	**Pelicans**
Pelecanus occidentalis	Brown Pelican
Family Ardeidae	**Herons and Egrets**
Ardea herodias	Great Blue Heron
Casmerodius albus	Great Egret
Egretta thula	Snowy Egret
Nycticorax nycticorax	Black-crowned Night-Heron
Family Anatidae	**Ducks and Geese**
Anas platyrhynchos	Mallard
Family Accipitridae	**Hawks**
Buteo jamaicensis	Red-tailed Hawk
Falco sparverius	American Kestrel
Family Charadriidae	**Plovers**
Charadrius vociferus	Killdeer
Family Scolopacidae	**Sandpipers**
Catoptrophorus semipalmatus	Willet
Numenius phaeopus	Whimbrel
Family Laridae	**Gulls and Terns**
Larus philadelphia	Bonaparte's Gull
Larus californicus	California Gull
Larus occidentalis	Western Gull
Larus delawarensis	Ring-billed Gull
Sterna caspia	Caspian Tern
Sterna forsteri	Forster's Tern
Sterna antillarum	Least Tern
Family Columbidae	**Pigeons and Doves**
Columba livia	Rock Dove
Zenaida macroura	Mourning Dove
Family Apodidae	**Swifts**
Aeronautes saxatalis	White-throated Swift
Family Trocholidae	**Hummingbirds**
Calypte anna	Anna's Hummingbird
Family Tyrannidae	**Tyrant Flycatchers**
Sayornis nigricans	Black Phoebe
Tyrannus verticalis	Western Kingbird
Family Hirundinidae	**Swallows**
Stelgidopteryx serripennis	Northern Rough-winged Swallow
Petrochelidon pyrrhonota	Cliff Swallow
Petrochelidon rustica	Barn Swallow
Family Corvidae	**Jays, Crows**
Aphelocoma californica	Western Scrub-Jay
Corvus brachyrhynchos	American Crow
Corvux corax	Common Raven
Family Aegithalidae	**Bushtits**
Psaltriparus minimus	Bushtit
Family Mimidae	**Thrashers**
Mimus polyglottos	Northern Mockingbird
Family Sturnidae	**Starlings**
Sturnus vulgaris	European Starling
Family Parulidae	**Wood Warblers**
Geothlypis trichas	Common Yellowthroat
Family Emberizidae	**Sparrows and Towhees**
Pipilo crissalis	California Towhee
Passerculus sandwichensis	Savannah Sparrow
Melospiza melodia	Song Sparrow
Family Icteridae	**Meadowlarks, Blackbirds, Orioles**
Agelaius phoeniceus	Red-winged Blackbird
Molothrus ater	Brown-headed Cowbird
Sturnella neglecta	Western Meadowlark
Quiscalus mexicanus	Great-tailed Grackle
Icterus cucullatus	Hooded Oriole
Family Fringilidae	**Finches**
Carpodacus mexicanus	House Finch
Carduelis psaltria	Lesser Goldfinch
Family Passeridae	**Old World Sparrows**
Passer domesticus	House Sparrow

APPENDIX D:

Additional Observations from All Surveys Except Bird Survey

ADDITIONAL OBSERVATIONS

- The majority of vegetation species listed in Appendix B were observed in and around the project site during the Summer 2005 survey.

- *Salicornia subterminalis* was observed intermixed with other species (primarily *S. virginica*), both within transects but outside quadrats and outside transects, throughout both the Fall 2004 and Summer 2005 surveys, despite *S. subterminalis* showing a reduction in all transect pairs compared to Fall 2003.

- The western-most channel flap gate was fouled with *Mytilus galloprovincialis* (Mediterranean mussel) during the survey, as it was in Fall 2004.

- *Buteo jamaicensis* (red-tailed hawk) was observed throughout the various surveys of 2005.

- A deceased, exotic *Vulpes vulpes* (red fox) was observed on Culver Blvd near Fish sample stations 6 and 8.

- *Pseudacris regilla* (Pacific chorus frog) were not witnessed through nocturnal vocalizations (Davidson 1995) in either frequency, abundance, nor longevity as they were following storms in late October, early-mid November, and late December of 2004. Vocalizations of short duration and by relatively few individuals occurred late in 2005 and were first apparent following a storm.

- The ability to distinguish species and their percent cover within quadrats from digital images is quite feasible based on this additional survey practice. Attempts will be made to continue this practice in future surveys for which CLAEMD is responsible.

- Several *Didelphis virginiana* (common opossum) were observed deceased at various locations along both Culver and Jefferson Blvds throughout the year.

- Vacant shells of the invasive *Cepaea nemoralis* (brown-lipped snail, banded wood snail, or Spanish vaqueta) were observed frequently in wetland locations distant from channels and upland areas.

- Podocopid ostracods were ubiquitous in temporary pools in Areas A, B, and C following rain events in late winter and early spring.

- A vast, intermixed bed of *M. galloprivincialis* and *Anthopleura artemisia* (buried sea anemone) is prevalent just inside the SRTs at Station BWB3.

- Digenetic trematode schistosome cercariae of birds were highly abundant in both Ballona Wetlands and Lagoon during the summer and early fall as evident from cercarial dermatits contracted by a biologist sampling for macrofauna and subsequent dissections of *Cerithidea californica* (California horned snail).

ACKNOWLEDGEMENTS

We are grateful to Dr. Philippa Drennan for her taxonomic expertese, Kelly Rose, Otella Wruck, Ruth Lansford, and Barbara Courtouis of Friends of Ballona Wetlands for their willingness and efforts to help us with site access points and associated lock problems, Theresa “Terri” Stewart and Kent Smirl of CDFG and Mary Small of California Coastal Conservancy for their help in dealing with a person observed destroying public property of ecological preserve status while the vegetation survey was being conducted. Special credit is due to Brad Henderson of CDFG for technical guidance in the Technical Advisory Committee, biological insight, and good communication maintenance.

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