Chapter 4

Baseline Reference Study of Los Cerritos Wetlands Complex Soils

Conrad Conterno, Heather Nilson, Christopher Brian Pauley, Reid Shigeno, Shawn Turner

Abstract

The goal of the Hydro/Geochem Team's soil study was to establish a baseline for existing conditions across the Los Cerritos Wetlands complex. Fourteen soil cores, 15cm in length, were collected in the Slough, Degraded Marsh, Zedler Marsh and Callaway Marsh. Basic soil parameters (e.g. grain size, mineralogy, organic matter content, and salinity) were measured along with heavy metal concentrations. Median grain size in the complex is silt. The finest soils overall were found in the intertidal region of the Slough. Strong correlations exist between median grain size and heavy metal concentrations, with several notable exceptions including Sr and Mo. The mineralogy of the bulk samples is dominated by quartz and feldspar, consistent with weathered rocks from Southern California. The only exception is in the upper soil of Callaway Marsh, which has a significant fraction of manufactured material such as silicon carbide. Mineralogy of the clay fraction of the sediment includes muscovite, illite and clinochlore, all minerals that derive from the weathering of the coarser mineral fraction. The study of the organic carbon content showed that the Degraded Marsh could become a viable wetland, having reasonably high levels of organic carbon in the soils. Both Callaway and Zedler contained less organic carbon, although each is represented by a single sample. The salinity found in sample locations supports the notion that these soils can support life. Salinity content at Zedler and Callaway wetlands shows there is not enough salt to hinder the growth of multiple species of vegetation and animal life, while the Slough, being tidally influenced by the ocean and Los Cerritos Channel, had high salinity levels. Lastly heavy metals are present, increasing linearly with decreasing grain-size. FINFISH

Introduction

The study conducted by the California State University Long Beach 2007 Environmental Science and Policy (ES/P) 400 Hydro/Geochem Team was designed to create a baseline reference for future soil studies in the Los Cerritos Wetlands Complex. The two purposes of this study were to provide reference material for future ES/P 400 classes and to provide data that may support the classification of the area as a wetland. Evidence that identifies this location as a "wetland" is crucial for its future protection. Furthermore, determination of the "health" of the wetland (e.g. organic matter loss, heavy metal contamination, etc) will be critical for future restoration efforts.

Existing chemicals, soil composition, and hydrological qualities in the Los Cerritos Wetlands are of particular relevance for the definition of a wetland given that the three key properties in most definitions are hydric soil, high organic-matter content compared to uplands and the presence of hydrophytes (Mitsch and Gosselink, 1986). With this in mind, three basic soil parameters, grain size, mineralogy, and organic-carbon content, were measured to determine the ability of the soil to retain water, the availability of organic matter for plant growth, and the mineralogy, which influences the ground water chemistry and nutrient availability. Salinity was also measured because the Los Cerritos Complex is tidally influenced, and salt levels within the soil will determine which, if any, plants can survive.

The key factors of each test are as follows: **Grain size** is important to soil composition because it relates to sorption capabilities of contaminants and porosity (e.g. how well the soil may retain water). **Mineralogy** is important in determining which elements are available in the soil for plants. Furthermore, mineralogy can be used to identify non-natural components, such as industrial agents, which can cause harm to the soil processes and the organisms living there. **Organic carbon content** in soils is important because it is essential for plant growth. Organic material also binds soil and nutrients together through sorption. Measuring the carbon content can also help delineate the balance between the input of carbon to the soil and removal of carbon by decomposition. Simply stated, poor or degraded soils have low carbon content. **Salinity** is also very important to the soils of a wetland. It can determine what plants can grow and thrive in each soil location. Many plants cannot soak up water if salt concentrations in the soil are too high. However, plants in coastal wetlands are adapted to specific soil salinities and knowing the salinity of the soil informs biologists what plants can live there. **Heavy metal** content in soils can greatly impact the health of a wetland. Many heavy metals like cadmium, lead, and zinc pose a major risk to the health of the inhabitants of the wetlands and can be concentrated through bioaccumulation. These contaminants could also leach into the groundwater, which would extend the negative impacts beyond the wetland, itself.

Methods

Sample Collection

Four representative sites across the Los Cerritos wetland complex, including potential preservation and restoration locations, were selected to provide a spectrum of possible soil conditions (Fig. 4.1a). The sites include the Slough, which is presently a functioning salt marsh with tidal influence, the Los Cerritos Degraded Marsh (LCD)[1],

[1] Also referred to the "Campgrounds" in Chapter 5.

which was recently purchased by the Los Cerritos Wetland Authority, although the Bryant Co. has retained a section along 2nd Street, and Zedler and Callaway Marshes.

The Slough was divided into three lateral regions, from the rear of the marsh to the mouth (1 to 3, respectively), and into three tidal zones (supra, inter and subtidal) (Fig. 4.1b). One core was taken from each sub-region for a total of six cores. The lateral division provides an estimate of the influence of the Los Cerritos channel and Bahia Marina on the sediment of the slough. The tidal zones provide a measure of the tidal influence on the sediment. The tidal zones are defined as follows: subtidal (LS) is the region normally covered by water at low tide, intertidal (MS) is the region normally lying between low and high tide range, and supratidal (US) is the region generally above mean high tide. At the LCD site, three cores were collected along a transect away from the San Gabriel River (LCDR, LCDM, and LCDS, respectively). One core each was collected at Zedler and Callaway Marshes, which have tidal influence via the San Gabriel River. GPS coordinates of each location are listed in Table 1.

Table 4.1 Latitude and Longitude for sample sites

Location	Latitude	Longitude
LCDR1	33° 45.433’	118° 6.101’
LCDM2	33° 45.484’	118° 6.130’
LCDS3	33° 45.541’	118° 6.156’
US1 (supratidal)	33° 45.865’	118° 6.346’
US2	33° 45.899’	118° 6.456’
US3	33° 45.888’	118° 6.647’
MS1 (intertidal)	33° 45.827’	118° 6.341’
MS2	33° 45.881’	118° 6.477’
MS3	33° 45.857’	118° 6.671’
LS1 (subtidal)	33° 45.812’	118° 6.347’
LS2	33° 45.873’	118° 6.475’
LS3	33° 45.843’	118° 6.670’
ZEDLER	33° 45.361’	118° 5.988’
CALLAWAY	33° 45.149’	118° 6.275’

Los Cerritos Wetlands

Fig. 4.1a. Map of the Los Cerritos Complex showing location of soil cores.

Los Cerritos Wetlands

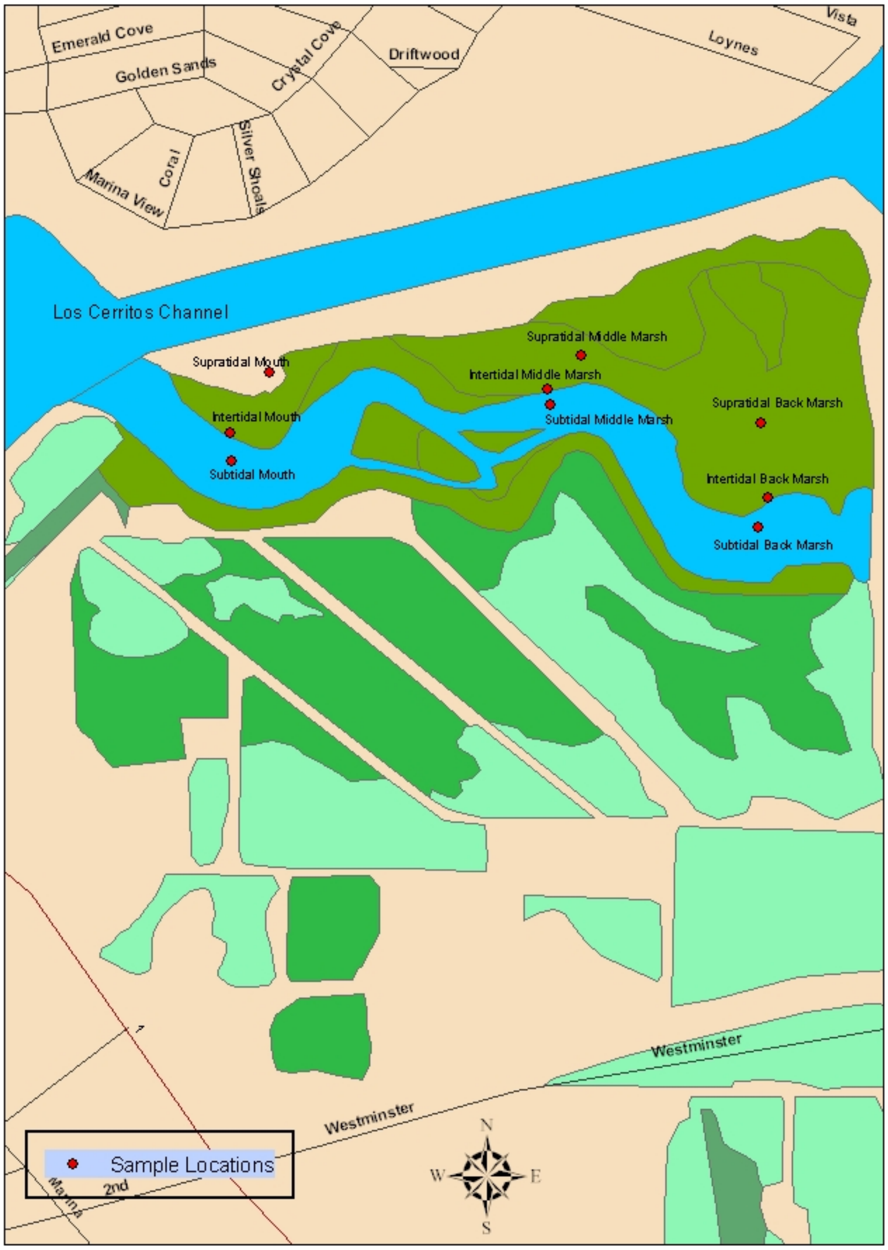


Fig. 4.1b. Enlargement of the Slough showing lateral and tidal sample transects.

Fig 4.1c. Enlargement of Los Cerritos Degraded, Zedler, and Callaway Marshes

Soil cores, 15 cm in length, were collected with an AMS® slide hammer soil corer with a 1.5 inch diameter barrel. Each sample was taken and stored in oriented plastic sleeves for protection until laboratory analysis. In the subtidal area of the slough, samples were collected from a boat with a Livingston square-rod piston corer. Cores were extruded in the field and stored in PVC pipe for protection. Cores were extruded from the plastic sleeves and PVC pipe in the laboratory and described. They were then cut into 3 cm sections. Wet weights were recorded prior to freeze-drying. Dry weights were used to calculate bulk density. Three sample sections (0-3, 6-9, and 12-15 cm) per soil core were used for the analyses. The remaining sections were archived for future use. A sub-sample, approximately 5 g in mass, was removed for grain-size analysis. This was done prior to crushing and homogenization of the remainder of the sample for the other soil tests. This step was inadvertently skipped during processing of the sub-tidal (LS) cores, resulting in loss of grain size data for this portion of the slough. All soil tests were conducted in the Department of Geological Sciences, while heavy metal analysis was conducted in the Institute for Integrated Research in Materials, Environment, and Society (IIRMES), CSULB.

Mineralogy

The mineralogy was determined with standard x-ray diffraction on a Rigaku® Mini-Flex diffractometer equipped with a Cu/K-α x-ray tube. One slide was prepared for each of the 42 samples collected. In addition, 13 more slides were prepared with the clay-sized fraction from the grain size measurements. Diffraction patterns were analyzed with the JADE™ computer program.

Grain Size

Grain size analysis followed standard sieve and pipette protocol as outlined by Lewis and McConchie (1994). This procedure required wet sieving of the sediment first at 0.25 mm to remove the coarse sand fraction and then at 0.0625 mm to remove the fine sand fraction. Flow-through was mixed with 1-L of dispersant for the pipette analysis. The pipette analysis involved extraction of 20-ml samples at specified timed intervals. The extraction of each sample took place at a specified depth depending upon the water temperature. The 20-ml samples were oven dried to remove all of the water, weighed, and adjusted for 1000-ml content. Cumulative weights were calculated at 2, 4 and 8 ϕ and graphed. Median grain size and percent sand, silt, and mud were then calculated from the graphs using standard equations (Boggs, 2000) and are reported in ϕ units. Raw data are reported in Appendix A.

Organic carbon content

Carbon content was measured using the loss-on-ignition method (Dean, 1974). Samples were combusted in a muffle furnace at 950° C for two hours. The amount of mass lost is then used to determine total organic carbon. Values are reported as percent TOC (total organic carbon), calculated by ratio of the weight of the sample lost to the weight of the original sample. Raw data are included in Appendix B.

Soil Salinity

Soil salinity was measured with a Hach® Electrical Conductivity meter. A dry, homogenized sample, 5-20g in weight, was mixed in a 1:1 ratio with 18.3 megaohm water. The solution was allowed to soak for several hours to come to equilibrium. The water was then separated from the solution either by filtration or centrifuging. The electrical conductivity meter measures the total dissolved solids in the water as well as temperature. Measurements of the degraded sites (LCDR1, LCDM2, and LCDS3) used vacuum filtration, which provided little water for analysis. All the other sites were measured by placing the solution in a centrifuge. The heavy soil material was forced to the bottom of a test tube and the separated water was easily accessible for measurement using the probe of the electrical conductivity meter. Three samples (MS1 0-3, MS1 6-9, and MS3 0-3) did not produce enough water for an accurate reading. The electrical conductivity meter automatically corrects for temperature. Results are given as though the measurement was taken at 25°C.

Heavy Metal Concentration

500mg samples were weighed and added to nitric and hydrochloric acid to remove loosely held heavy metals following the method outlined in EPA Method #3052. After the samples were successfully digested, they were diluted and measured on a Perkin-Elmer 6100 ICP-MS under the supervision of Chris Mull. Metal values were corrected for standards, blanks and dry weights. Values are reported in ppm (see Appendix C).

Unfortunately instrument difficulties reduced the available data set. During the first run, the argon gas unit expired, and several samples did not get analyzed. Additionally, the plasma array experienced a malfunction, which affected some of the results, reducing the number of reliable data. Additional problems were encountered with manipulating the data after the samples were run. There was not enough time to sufficiently troubleshoot and quality check our dataset. Therefore, the following samples do not have reliable metals values: Zedler 6-9, 12-15; Callaway (all); Intertidal Back (0-3cm); LCDR (0-3); Supratidal Middle (6-9); Intertidal Back (6-9); Subtidal Mouth (12-15); Supratidal Back (12-15); Degraded Middle (12-15).

Results

Results of the grain size analysis for all samples (except subtidal Slough) are listed in Table 4.2. The mean grain size or phi size is reported along with the percent of sand, silt, and mud from each sample. Average phi values by site are shown on the far right.

The overall average grain size for all of the sites is 5.3 ϕ. This value is nearly identical to the average grain-size for the Los Cerritos Degraded Marsh (5.2 ϕ). The average phi size for the Slough is 5.8 ϕ. However, the average size of the supratidal zone (4.9ϕ) is significantly coarser than that of the intertidal zone (6.5 ϕ). Callaway and Zedler had the coarsest texture (3.9 ϕ), which is consistent with sand. *However, the samples were collected near the inlets, which may have coarser material deposited by the river.*

Table 4.2. Median grain size (in ϕ) per sample, cumulative weight percent of sand, silt, and mud per sample, and average grain size (in ϕ) per field area. Boxes indicate samples with a median ϕ equivalent to sand rather than silt.

	Median	%sand	%silt	%mud		
US1 0-3					average slough	5.8
US1 6-9	7.0	6	67	27	average upper	4.9
US1 12-15	6.7	7	69	24	average middle	6.5
US2 0-3	5.5	50	24	26		
US2 6-9	4.1	56	43	1		
US2 12-15	4.5	41	56	3		
US3 0-3	3.6	77	15.5	7.5		
US3 6-9	3.2	88	12	0		
US3 12-15	can't calc	80				
MS1 0-3	7.2	16	45	39		
MS1 6-9	6.9	10	55	35		
MS1 12-15	7.4	4	60	36		
MS2 0-3	7.0	16	45	39		
MS2 6-9	5.8	18	67	15		
MS2 12-15	5.0	41	46	13		
MS3 0-3	5.6	26	67	7		
MS3 6-9	6.5	15	67	18		
MS3 12-15	6.9	13	54	33		
lcdr0-3	6.3	24	46	30	average degraded	5.2
lcdr6-9	5.0	46	34	20		
lcdr12-15	can't calc	20	34	46		
lcdm0-3	6.0	24	53	23		
lcdm6-9	4.9	50	30	20		
lcdm12-15	can't calc	13	46	41		
lcds0-3	4.7	50	33	17		
lcds6-9	4.8	46	39	15		
lcds12-15	4.9	36	51	13		
CM0-3	5.1	38	46	16	average C/Z	3.9
CM6-9	3.2	69	28	3		
CM12-15	3.0	74	19	7		
ZM3-6	no data					
ZM6-9	4.0	53	36	11		
ZM12-15	4.2	54	33	13		
average	5.3	37	44	20		

The distribution of sand, silt, and mud for the entire Los Cerritos complex and each of the four sub-regions is shown in Fig. 4.2. The average percent sand from all samples measured is 37 %. The average percent of silt is 44 %, and the average percent of mud is 20 %. Inlet values for Callaway and Zedler Marshes together have 58 % sand, 32 % silt, and 10 % mud. This distribution is not significantly different than that of the Supratidal Slough zone. In contrast, the Intertidal Slough has only one-fifth of that amount of sand (11 %) sand and twice as much mud (27 %). Values for the degraded marsh fall between these two end members. Furthermore, within the supratidal zone of the Slough, there is a distinct trend of increasing amount of sand at all stratigraphic levels toward the mouth of the Slough (Fig. 4.3).

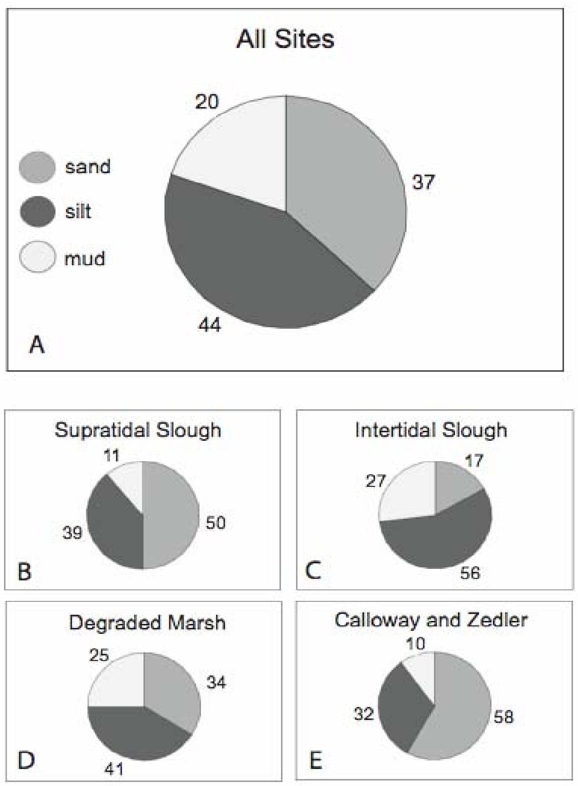
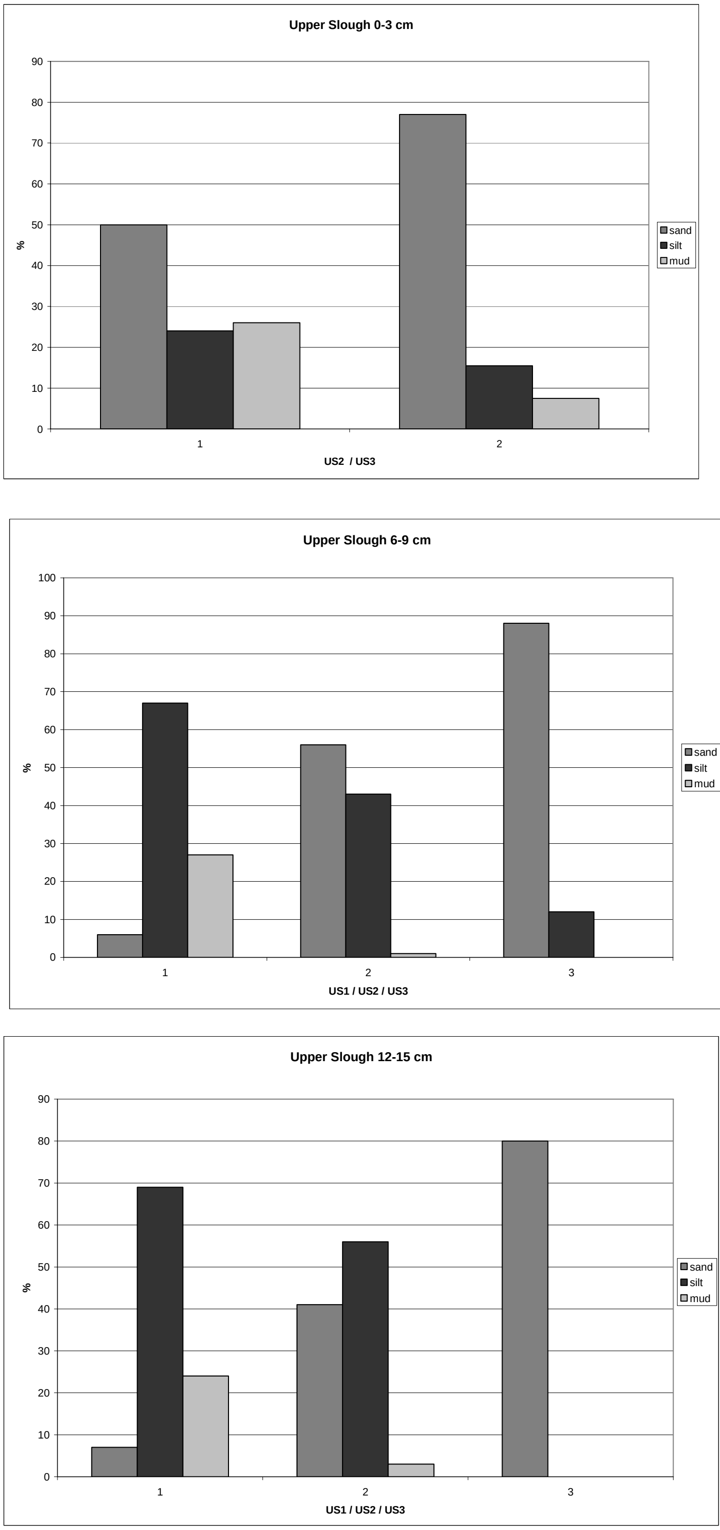


Fig. 4.2. Pie charts showing average percentages of sand, silt and mud for a) all sites; b) supra-tidal zone of Slough; c) inter-tidal zone of the Slough; d) Los Cerritos degraded marsh; e) Callaway and Zedler marshes.



0-3 cm

6-9 cm

12-15 cm

Rear **Mouth**

Fig. 4.3. Average percent of sand (dark grey), silt (black), and mud (light grey) in the supratidal zone of the Slough for 0-3 cm, 6-9 cm, and 12-15 cm depths.

A plot of each sample on the USDA Soil Texture Chart (Fig. 4.4) indicates that much of the soil, including the Degraded Marsh samples, falls within the silty loam and loam categories.

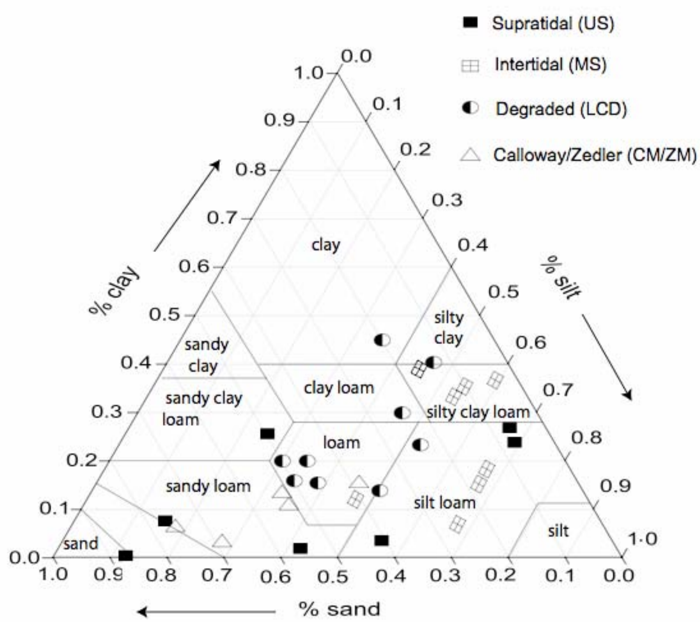


Fig. 4.4. Ternary diagram showing the soil textures for each soil core.

Despite the differences in grain size, the soil at each site consists of very common rock-forming minerals, with only Callaway Marsh as a major exception (Fig. 4.5b). Quartz was the most abundant mineral, found in 35 of the 42 samples and at least once at each location. Albite (Na-feldspar), anorthite (Ca-feldspar), and orthoclase (K-feldspar) are common detrital minerals that were also frequent. Halite (salt) was found in every location on the surface. It was present in the Slough at all depths, as well. The clay-sized fraction included clinochlore and muscovite, both phyllosilicates that readily weather to clays. Illite (K-Al silicate) was the major clay mineral.

The 0-3 cm and 6-9 cm strata of Callaway Marsh contained primarily synthetic compounds that possible include Bromouracil-5, Copper Arsenic Selenide, Lithium Hydride, and Silicon Carbide. Quartz was minimal in these levels. However in the 12-15 cm sample, the composition of Callaway was consistent with the overall mineralogy of the rest of the wetland complex. Fig. 4.6 shows the overall distribution of minerals found in the Los Cerritos Wetlands Complex.

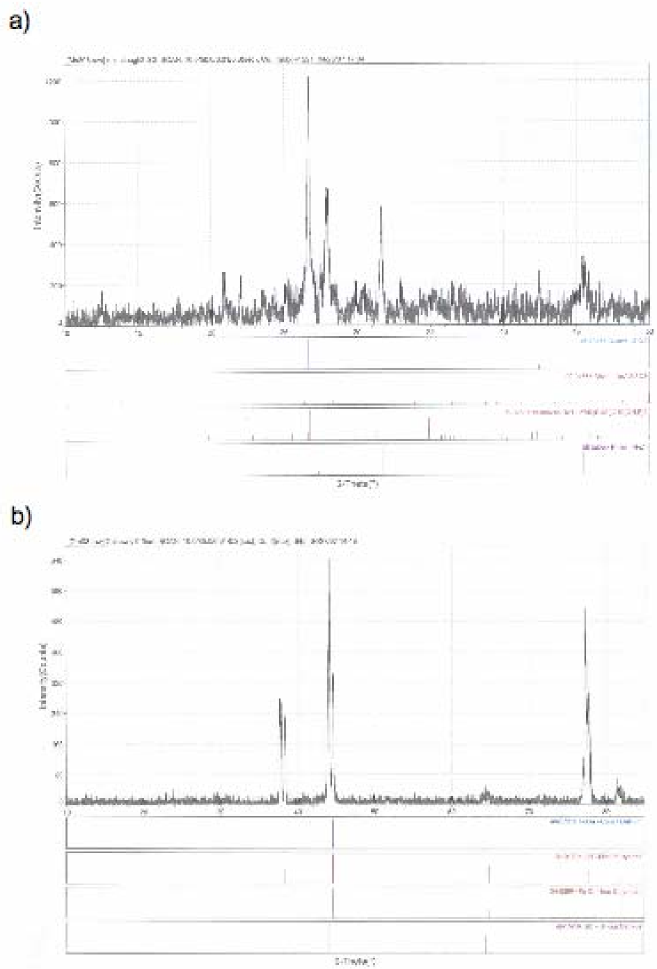


Fig. 4.5 X-ray diffractograms for a) the surface of the intertidal slough (MS 0-3) and b) the surface of Callaway Marsh.

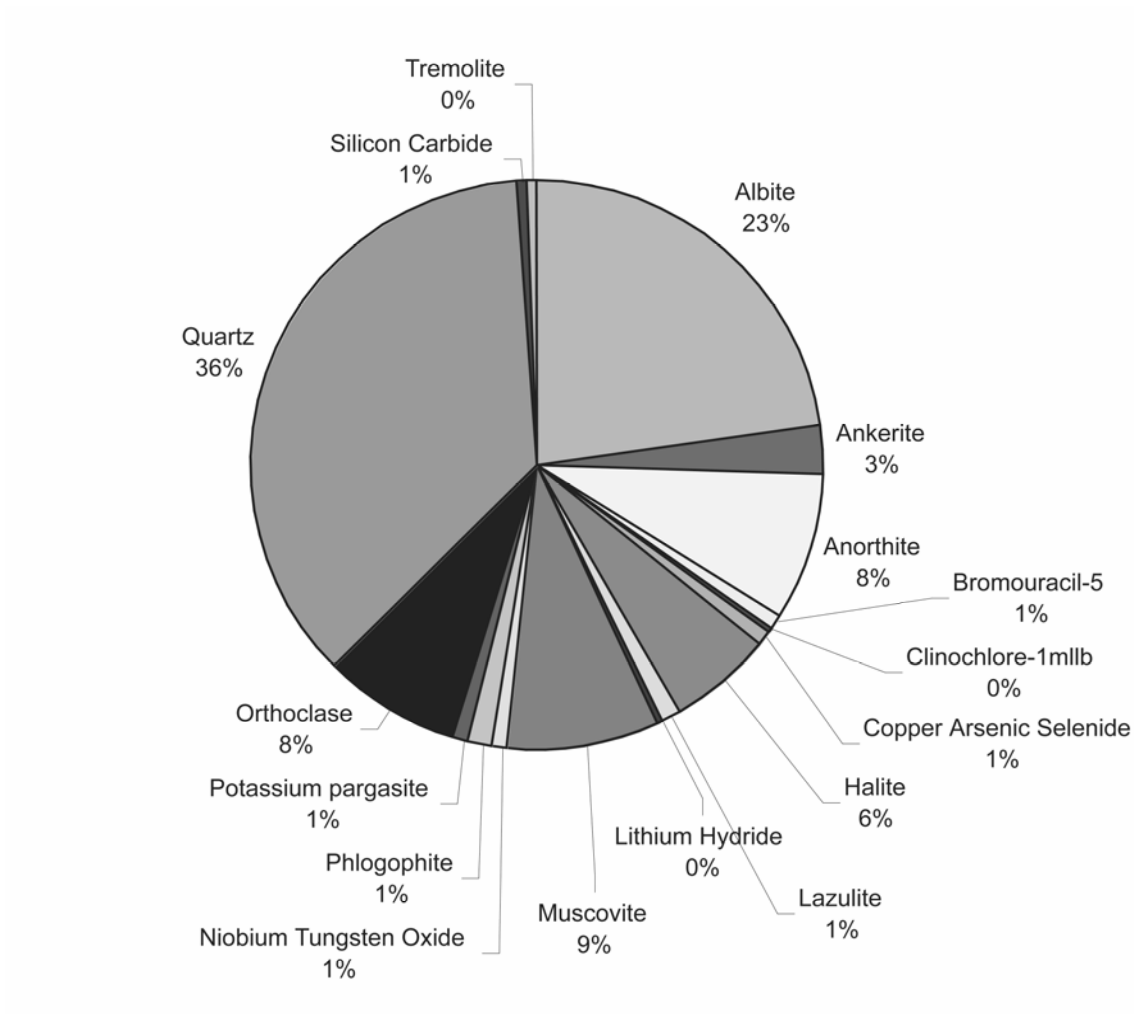


Fig. 4.6. Abundance of minerals in the Los Cerritos wetlands complex based on x-ray diffraction peak intensities.

Organic carbon content of the soils ranges between 2 and 22 % across the wetland (see Table 4.3a-e). Although there are no clear differences between the various wetland sites, there are several notable features within sites. Within the Slough, TOC decrease from the rear to the mouth. There is also in general a trend of more organic carbon content in the soils closer to the surface. Finally, both Callaway and Zedler Marshes have little organic carbon content in the upper section of the soil.

Table 4.3. Percent organic carbon content for a) each depth range, b) each location, c) each location at 0-3 cm, d) each location at 6-9 cm, e) each location at 12-15 cm.

a

Depth	Organic Matter %
0-3	11.67%
6-9	7.99%
12-15	7.79%

b

Location Average	Organic Matter %
MS1	16.61
MS3	13.50
US1	11.57
LCDM2	9.96
LCDR1	9.28
MS2	8.66
US2	8.32
LCDS3	8.18
LS2	7.84
Calloway	7.31
LS1	6.07
Zedler	4.92
LS3	4.05
US3	3.82

c

Location @ 0-3 cm	Organic Matter %
MS1	24.88
US1	18.35
US2	17.22
MS3	16.95
LCDR1	15.28
Calloway	14.69
MS2	13.91
LSDM2	13.71
LCDS3	11.46
Zedler	11.36
LS1	8.56
US3	6.56
LS2	5.72
LS3	4.61

d

Location @ 6-9 cm	Organic Matter %
MS1	21.67
MS3	15.31
US1	12.15
MS2	9.56
LCDS3	7.26
LS1	6.95
LCDR1	6.83
LS2	6.23
LCSM2	5.97
Calloway	5.16
Zedler	4.39
LS3	4.29
US2	3.50
US3	2.54

e

Location @ 12-15 cm	Organic Matter %
MS3	15.55
MS1	12.85
LS2	12.83
LCDM2	11.80
US1	11.73
LSDR1	8.32
LS1	6.27
LSCS3	6.12
US2	4.56
MS2	4.29
Zedler	4.28
Calloway	4.11
LS3	3.94
US3	2.35

The average electrical conductivity for each location is shown in the following table (MS1 and MS3 were omitted) Table 4.5. Table 4.5 shows the average electrical conductivity of each depth the salinity at 0-3 cm.

Table 4.4. Salinity Conductivity Categories (from XXX)

Salinity Class	**Ece Range** (dS/m)	**Description**
Non Saline	< 2 dS/m	• No vegetation appears affected by salinity and a wide range of plants present.
Slightly Saline	2 – 4 dS/m	• Salt tolerant species such as sea barley grass are often abundant. • Salt sensitive plants in general show a reduction in number and vigour and salt sensitive legumes (eg. white and sub–clover, soybeans, chick pea, etc.) in particular show a noticeable reduction in vigour and number. • At the upper end of the range, grasses and shrubs may be prominent in the plant community. • There are no bare saline patches and no salt stain/crystals are evident on bare ground.
Moderately Saline	4 – 8 dS/m	• Salt tolerant species begin to dominate the vegetation community and all salt sensitive plants are markedly affected by soil salinity levels. • At the upper end of the range, some slightly tolerant species disappear and are replaced by others with higher salt tolerance. Legumes are almost non-existent as the plant community is dominated by grasses, shrubs and flat weeds. • Small bare areas up to 1 m2 may be present and salt stain/crystals may sometimes be visible on bare soil at the upper end of the range.
Highly Saline	8 – 16 dS/m	• Salt tolerant species like sea barley grass and buck's horn plantain may dominate large areas and only salt tolerant plants remain unaffected. • In low rainfall areas it is unlikely that any improved species will be present and trees may be showing some effect ie, dieback and stagginess. • Large, bare saline areas may occur showing salt stains or crystals (on some soils a dark organic stain may be visible), or the top soil may be flowery or puffy with some plants surviving on small pedestals and the B horizon may be exposed in some areas. • At the upper end of the range, halophytic plants may dominate the plant community and some species may show a reddening of the leaves.

Extremely Saline	> 16 dS/m	• Only highly salt tolerant plants survive and the community will be dominated by 2 or 3 species. Moderately and highly salt tolerant species may show a reddening of the leaves and at the upper end of the range even highly salt tolerant plants may be scattered and in poor condition. • Trees will be dead or dying. • Extensive bare saline areas occur with salt stains and or crystals evident (on some soils a dark organic stain may be visible. Top soil may be flowery or puffy with some plants surviving on small pedestals and the B horizon may be exposed in some areas.

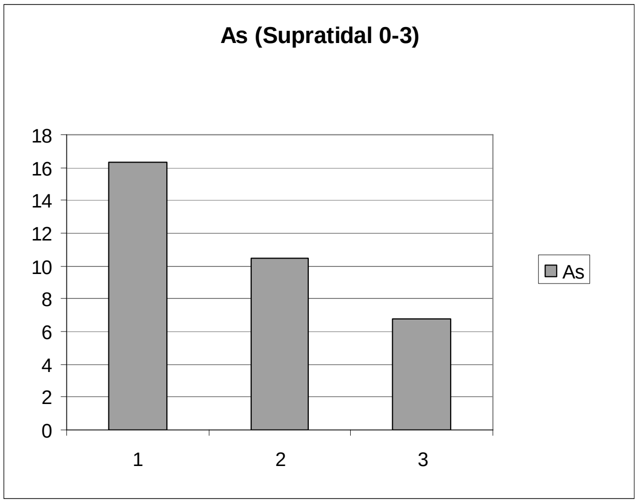
Location	Measurement Ds m -1 @ 25° C	Salinity Class
US3	>19.95	Strongly Saline
LS3	12.82	Strongly Saline
LCDM2	10.93	Strongly Saline
US2	8.85	Strongly Saline
Zedler	5.75	Mod Saline
MS2	5.37	Mod Saline
Calloway	5.26	Mod Saline
LS2	4.84	Mod Saline
LS1	3.83	Mod Saline
LCDR1	2.90	Slightly Saline
US1	1.71	Slightly Saline
LCDS3	0.72	Non-Saline

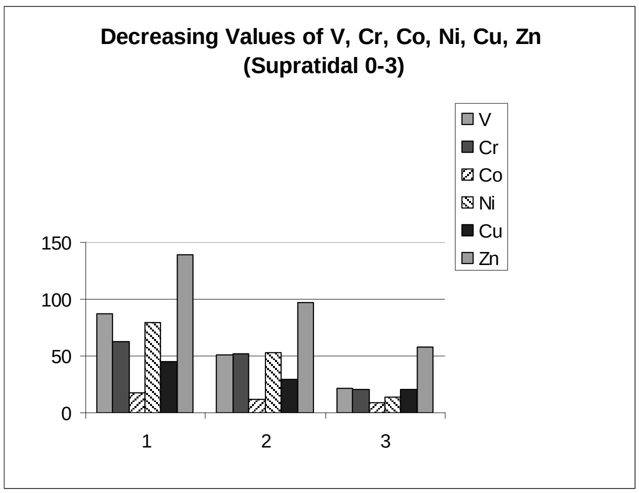
Location @ 0-3 cm	Measurement Ds m -1 @ 25° C	Salinity Class
US3	>31.25	Strongly Saline
LS3	12.16	Strongly Saline
LS3	7.94	Strongly Saline
LCDM2	7.42	Strongly Saline
US2	4.00	Mod Saline
US1	2.34	Slightly Saline
LS1	1.97	Slightly Saline
Zedler	1.48	Very Slightly
Calloway	1.33	Very Slightly
LSDS3	1.30	Very Slightly
MS2	0.14	Non-Saline
LCDR1	0.02	Non-Saline

Depth (cm)	Measurement Ds m -1 @ 25° C	Salinity Class
0-3	5.95	Mod Saline
6-9	5.55	Mod Saline
12-15	9.10	Strongly Saline

Table 4.5a Average electrical conductivity and salinity class for each location
Table 4.5b Average electrical conductivity and salinity class of each depth
Table 4.5c Average electrical conductivity and salinity class at 0-3 centimeters

With respect to metals concentrations, there appears to be a very clear trend in the supratidal marsh sample areas. The metal concentrations in the supratidal zone across all profiles (0-3, 6-9, 12-15) decrease moving from the rear portion of the slough towards the mouth. For the 0-3 profile, the concentrations of Be, V, Cr, Co, Ni, Cu, Zn and As decrease as you move from the back of the marsh to the mouth.(see Fig 4.7) For the 6-9 profile, the concentration of Be, V, Cr, Co, Ni, Cu, Zn, As and Sr decrease as you move from the back of the marsh to the mouth. (see Fig 4.8) For the 12-15 profile, the concentrations of Be, V, Cr, Co, Ni, Cu, Zn, As, and Ba decrease as you move from the back of the marsh to the mouth.





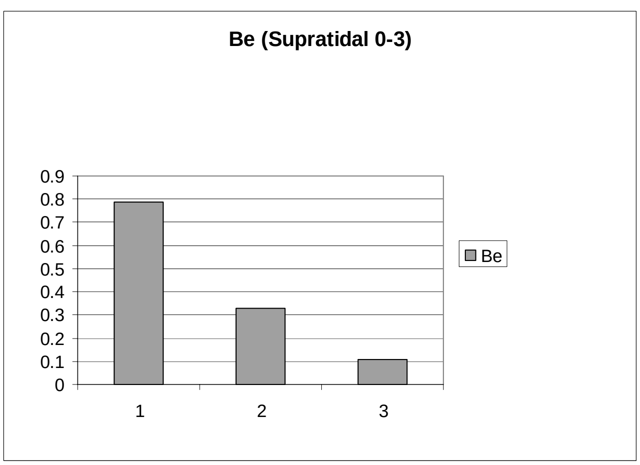
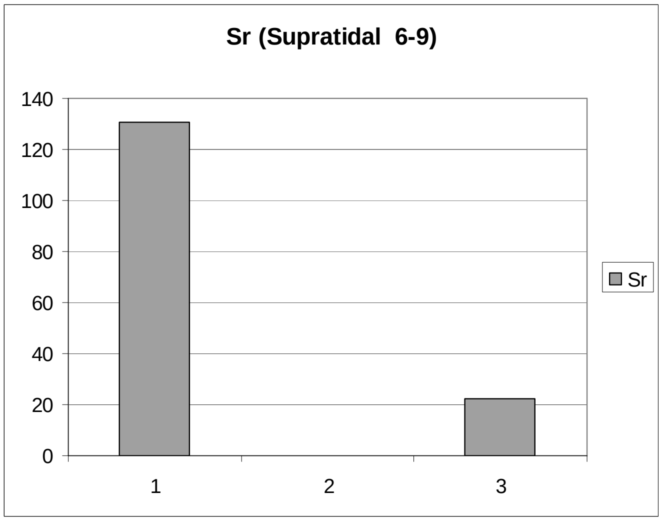
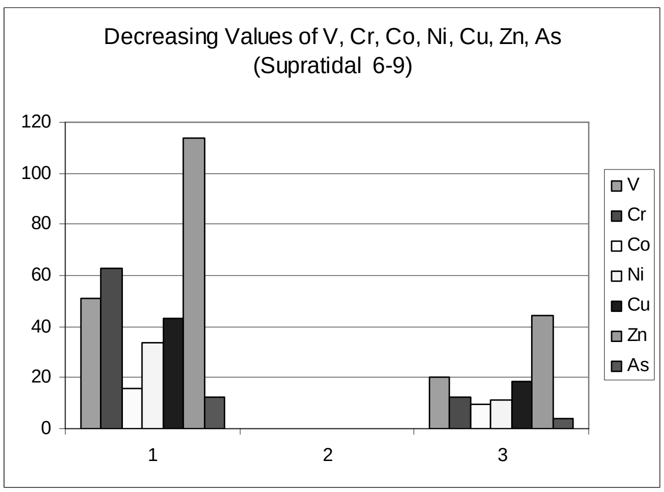


Figure 4. 7Graph of decreasing metals values for the Subtidal 0-3cm profiles

(1= Back Marsh, 2=Middle Marsh, 3= Mouth)





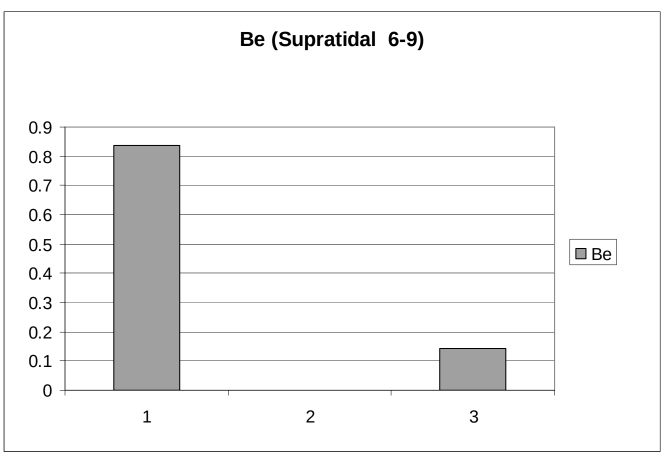
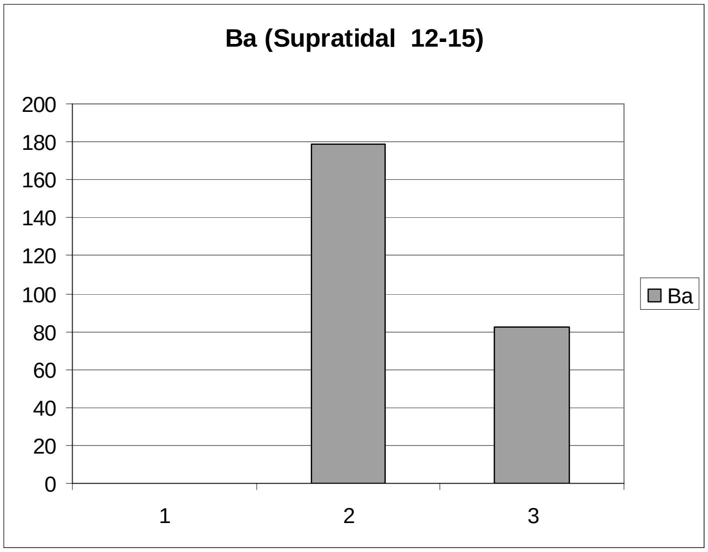
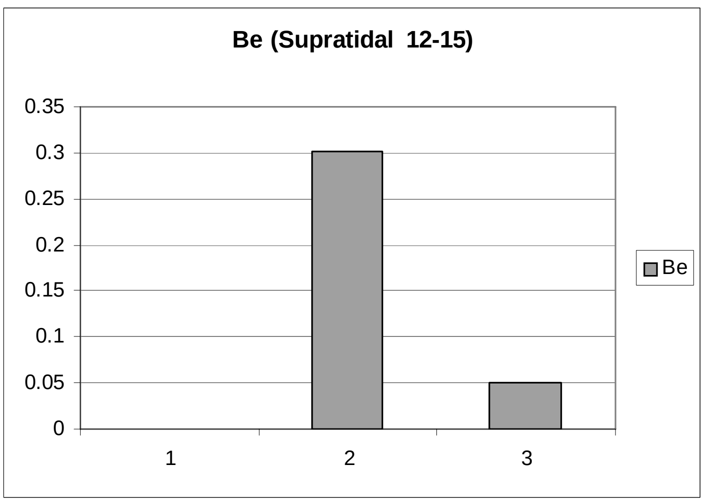


Figure 4.8 Graph of decreasing metals values for the Supratidal 6-9cm profile

(1= Back Marsh, 2=Middle Marsh, 3= Mouth)





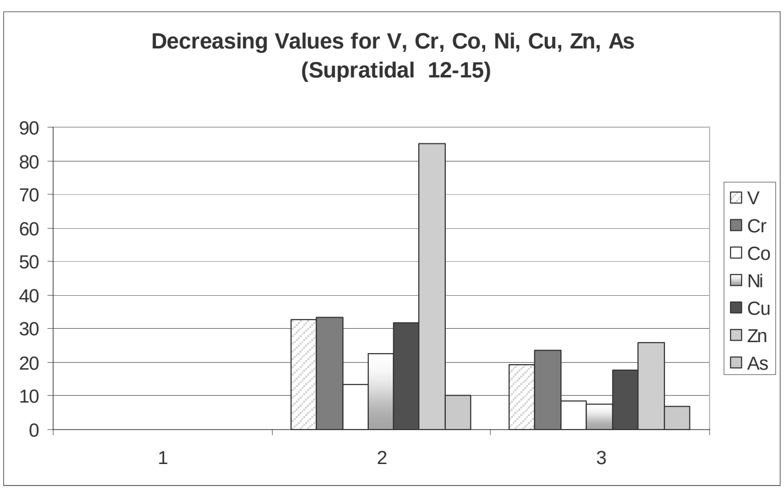
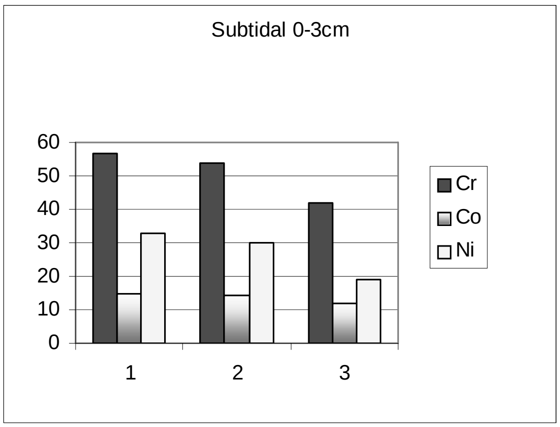
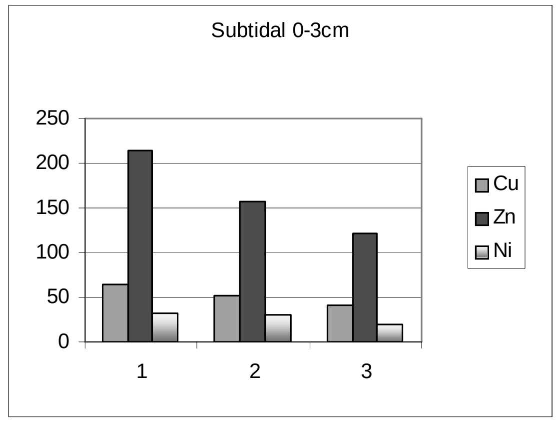


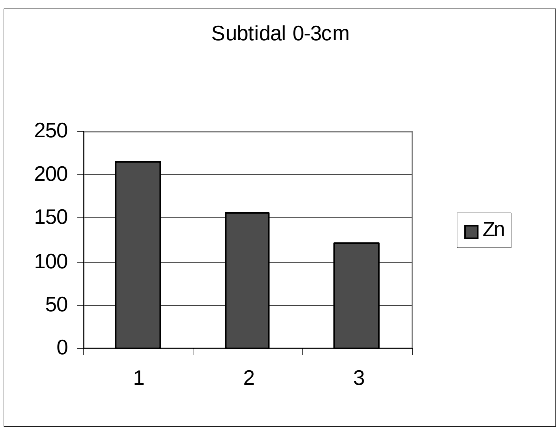
Figure 4.9 Graph of decreasing metals values for the 12-15cm profile

(1= Back Marsh, 2=Middle Marsh, 3= Mouth)

In addition to the trends with the Supratidal zone, there was a similar decreasing metals trend with the Subtidal zone in the 0-3cm profile (See Figure 4.10).







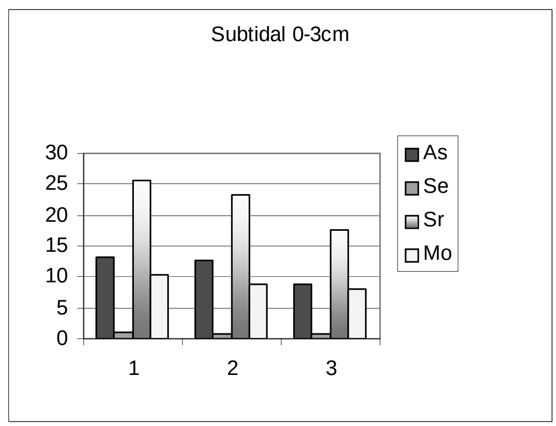


Figure 4.10 Graphs of decreasing metals values for the Subtidal   0-3cm profile

(1= Back Marsh, 2=Middle Marsh, 3= Mouth)

With the Supratidal zone, there is also a distinct trend with respect to the increase in the grain size of the cores as you move from the back of the marsh to the mouth In figure 4.3 you can see that the percent of sand in the sediment increases as you move from the rear of the slough to the mouth and the percent of silt and mud decrease as you move from the rear of the slough to the mouth. With respect to grain size, the following metals were shown were found to be negatively correlated with grain size. (Smaller grain sizes showed higher metals concentration) See Table 4.6,

Analyte	R-Squared
Copper	0.6255
Tin	0.3621
Chromium	0.8076
Arsenic	0.6255
Beryllium	0.77
Cobalt	0.6983

Table 4.6: Correlations of metals with grain size(metals vs ϕ).

See also Figures 4.11 - 4.15

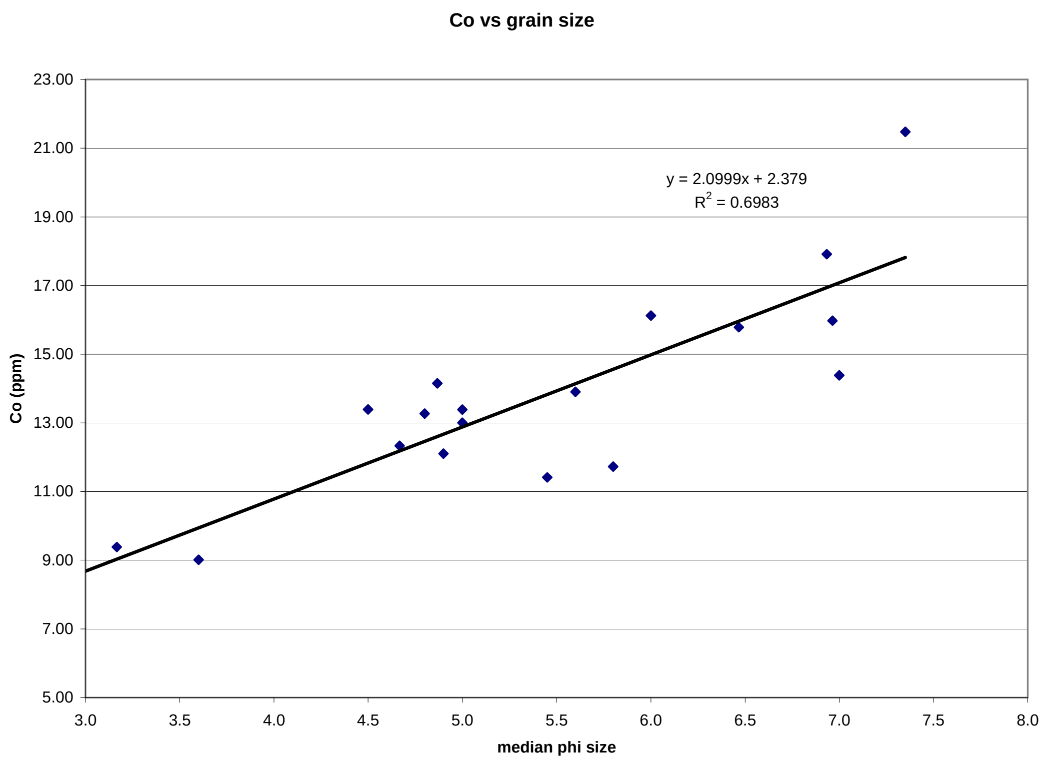


Figure 4.11_ Graph showing the correlation of grain size & cobalt

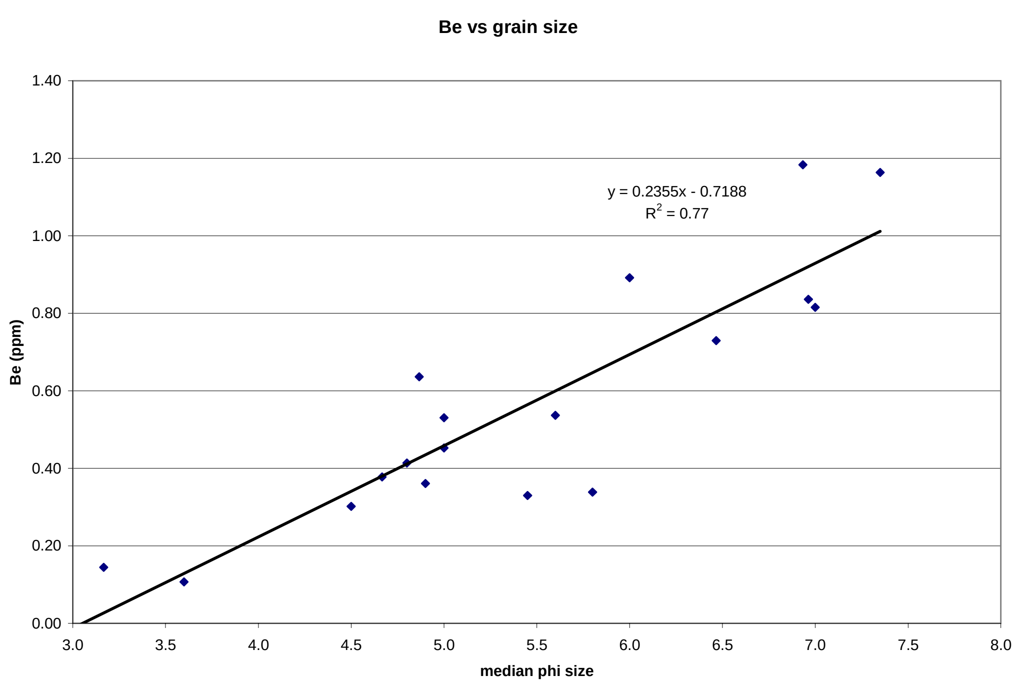


Figure 4.12 Graph showing the correlation of grain size & beryllium

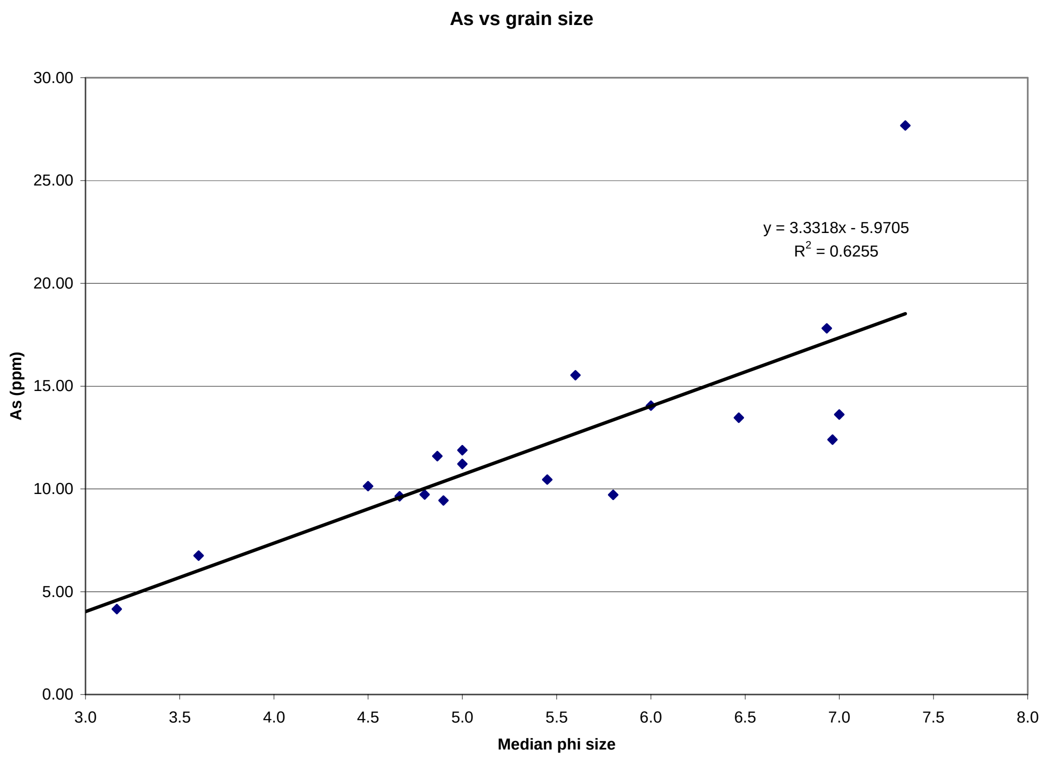


Figure 4.13 Graph showing the correlation of grain size & Arsenic

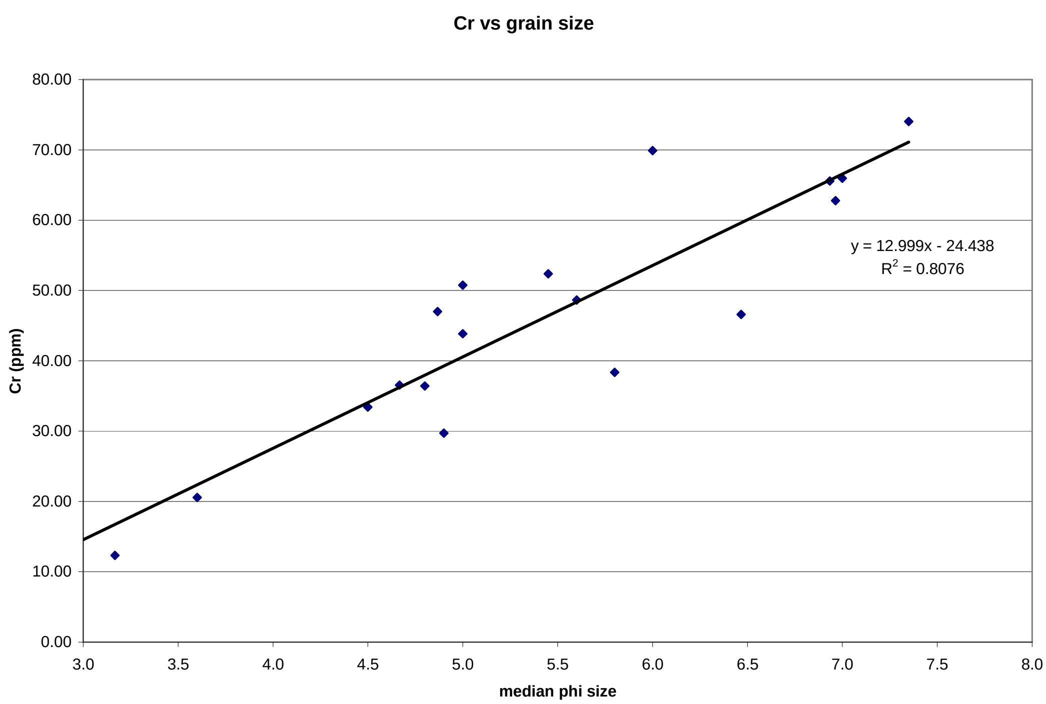


Figure 4.14 Graph showing the correlation of grain size & chromium

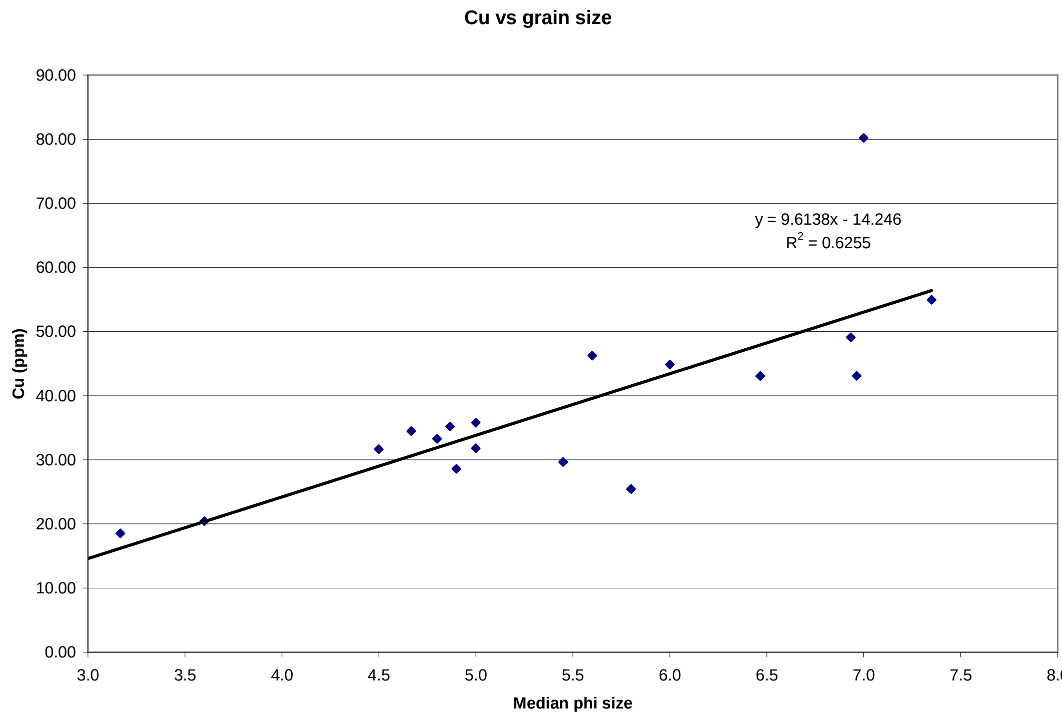


Figure 4.15 Graph showing the correlation of grain size & copper

Discussion

The mineralogy of the Los Cerritos wetlands is, with the exception of Callaway marsh, exactly what we would expect to observe for the given location. The frequency and quantity of quartz in the samples is no surprise. It is very commonly found in many varieties across the surface of the Earth

Albite and anorthite, of the Plagioclase Feldspar series, are generally found in igneous, metamorphic and occasionally sedimentary rocks. Their presence in the soil is reasonable. The frequency of orthoclase can be paralleled with that of albite. The two are both considered Alkali Feldspars and have a common occurrence (Klein and Hurlbut, 1985).

Halite is a common mineral, expected in a coastal wetland setting, influenced by the ocean. Salt, the household name for halite, is found throughout the Los Cerritos wetlands soil. It is the most prevalent in the Slough, where tidal inundation leaves deposits behind regularly. The presence of salt in LCD is likely the result of dredge spoils, which were used as fill. Future restoration and inundation of this area would yield brackish wetland conditions and encourage the growth of halophytic plants species.

The Phyllosilicates, muscovite and clinochlore, were seen in the fine grain samples tested. The occurrence of illite, a derivative of these minerals, can be attributed to their presence. These compounds do not have the same strong angular reflectivity as quartz therefore to detect their presence the largest grains had to be filtered out. These clay particles, with small surface area, encourage adhesion and increase the soil's ability to hold water and nutrients.

Callaway Marsh had the only major variation in composition. The high levels of foreign chemicals contained in the soil overshadowed traces of other compounds. None of the observations in the top 12 cm of the core, except small amounts of albite at 6-9cm, are naturally occurring; suggesting this zone is contaminated.

Silicon carbide is a compound utilized in many different industries in a variety of applications; NASA's advanced electronics, automotive disk brakes, and the steel industry all makes use of it. Silicon carbide is a synthetic compound that is very rarely found to exist in nature (Kelley, 2005). The outstanding level contained in Callaway marsh seems to be the result of direct contamination.

Non-natural chemicals found in Callaway Marsh include Lithium hydride, Bromouracil-5, and Copper Arsenic Selenide with in the 0-3 cm and 6-9cm samples.

Lithium hydride, found in the 0-3cm range of Callaway is questionable. There is no doubt that chemicals with similar x-ray diffraction patterns are in the soil. The instability of Lithium Hydride with air and water makes its occurrence unlikely. Bromouracil-5 is unlikely to be found in the soil, however identified in Callaway 6-9cm, and is used as a mutagen in DNA experiments (http://big.mcw.edu/display.php/755.html). In order for this to be present in the large quantities that were displayed, direct disposal of the chemical into the ground would be required. Copper Arsenic Selenide was the most prominent in the 6-9cm portion of Callaway. Inorganic Arsenic compounds are known human carcinogens that affect the skin, lungs and liver. Problems with these chemicals arise from inhalation or consumption (Dierks, 1994).

Irregularities of Callaway marsh's soil disappeared at a depth of 12cm. No heavy metals or synthetic compounds were evident in x-ray diffraction. The albite, quartz and ankerite composition mirrored what was seen commonly elsewhere. The high levels of dangerous synthetic compounds in the top 2 strata of Callaway Marsh soil samples are likely the result of waste dumping. The concentrations outweighed quartz by such an extent that their existence by indirect means seems improbable.

Although not directly analyzed the presence of oil was seen in the supratidal portion of the middle and mouth of the slough. Tar was observed in the middle marsh at the supratidal portion. This evidence suggests that there is also pollution coming in from the marina and could be examined in the future.

Organic carbon content on the other hand is helpful in order to see if there is nutrition viable through the organics for life to live. *There appears to be a trend of more organic carbon content in the soils closer to the surface.* The presence of organic carbon content due to animals and plants can be explained by their decomposition. The largest production of biomass occurs above the ground surface. Therefore, plant growth and the subsequent decaying plant materials create a higher level of organic matter towards the top soil. Similarly, animal matter decomposition creates high levels in soils close to the surface. Suggesting that although the sites have been filled there has been recent animal and plant activity.

In the 6-9cm sample (Fig. 5d), the organic carbon content average decreases. This is expected because of the higher level of organic material in the top soil compared to the lower soils. The Supratidal Middle Marsh, Degraded Marsh River, Degraded Marsh Middle, and Subtidal Middle Marsh follow this pattern. The Subtidal Middle Marsh is the only sample in which the highest percentage of organic carbon content is not at the 0 to 3cm sample (Fig. 5c).

The Slough showed a lower organic carbon content the closer to the mouth. This could possibly be due a higher tidal influence carrying away decaying organic matter more often at the mouth. The Subtidal Middle Marsh sample was collected from an area that contains more water.   The water could feed the organic carbon content but it could also wash it away. This may be the reason for the low levels in this sample. Organic matter creates stability in the soil but because this sample was in a less stable state than some of the others it would make sense for there to be less organic matter. On a whole because the sample is shallow, these four samples may be insignificant to the overall conclusion of the project.

The sample from 12cm to 15cm (Fig. 5e), on average, had the expected outcome. It had a lower level of organic carbon content than the top two layers. Again the decomposing matter takes time to penetrate the lower levels. One of the processes of organic matter is that it stores nutrients and water. A layer of nutrients and water under the top layer of organic matter can serve as another resource for the vegetation. The Degraded Marsh has the appearance of a desert but high levels of organic carbon content found at lower depths could result in unexpected vegetation.

Both Callaway and Zedler marshes showed little organic carbon content generally speaking. This was interesting because both sites appeared to have more plant and animal life than the degraded sites. They both additionally have a tidally influenced water supply from the San Gabriel River. The water supply along with the high levels of organic carbon content at the 0 - 3 cm levels (Fig. 5c) suggest that this system replenishes and functions on the top level. This differs from the Degraded Marsh where the data suggests the lower levels help to replenish and stimulate growth.

A possible error in this method is the loss of structure water in clay minerals. This would account of up to 20% weight loss for clay minerals. Samples with higher clay content would have loss more weight, appearing to have more organic carbon content. Another possible error could have been exposure time in the furnace. Some samples were placed in the furnace longer than others and in different crucibles.

The salinity averages of the samples are close to evenly dispersed within the categories with a slight rise in the moderately saline category (Fig. 7a). This is an interesting finding because of the sources of the samples collected. Each site had a different aesthetic look as well as a different process of receiving salt water if at all. To find a range of salinity in all areas suggests that through various sources and methods, all sites have or had contact with the ocean.

The Supratidal Mouth had the highest salinity on average (Fig. 7a) and in the 0-3cm range. The salinity content of the Supratidal Mouth should only produce highly salt tolerant plants (Fig. 6). According to the chart, there should be little plant growth in the area because of the high salinity. The plant life in this area of the Slough is very tolerable to high levels of salinity. The high salinity content is most likely due to the ocean's proximity.

In the highly saline category, vegetation should be struggling to survive. The only area that was observed in this condition was the Degraded Marsh. This could possible be due to lack of water source or pollution. The moderately saline category is present in four samples. In this category the vegetation is not crippled by the amount of salinity but had an affect on the plant life.

The next four samples that fall under both the slightly saline and the non saline categories are likely to have the most vegetation. This should make them the most viable for the restoration of the wetlands.

Although the average salinity samples explain the total salinity of the area, the 0-3 cm samples could explain in more detail why each one is not flourishing or if they should be restored. The Slough as a whole has more salinity than the rest of the sites. In the Supratidal Middle Marsh, Supratidal Back Marsh, Subtidal Middle Marsh, and Subtidal Back Marsh, samples (Fig. 7c) there are high levels of salinity ranking from extremely saline to moderately saline. The salinity in the Slough was higher at the mouth and gradually decreased the further back samples were taken. This could be due to salt deposits from tidal influence. The Slough as a whole has more salinity than the rest of the sites. In the Supratidal Mouth 2, 3, Subtidal 3, 2 samples (Fig. 7c) there are high levels of salinity ranking from extremely saline to moderate saline. This could cause the growth of only highly tolerable plants.

The samples from Zedler and Callaway at the 0-3cm level (Fig. 7c) read at a non saline level. This suggests that there will be no damage from the level of saline to the vegetation if restored. Another non saline level came from the Degraded Marsh. This also means that vegetation would not be affected by the saline level if restored.

Few true trends were present in the examining of the heavy metals among profile and site. The one clear trend that was observed with the metals values was the decrease in metals concentration as you move from the rear of the Slough towards the mouth. The main control on the metals concentrations within the Los Cerritos Wetlands Complex appears to be grain size. Smaller sediment grains have a larger surface area, therefore adsorbing more metals via surface charges. Previous studies have shown that trace metals can be transported via suspended sediments (Gibbs, 1977) and that finer grained suspended sediments have a larger more surface area and tend to accumulate more metals (Gibbs and others, 1998). Previous coastal wetland sediments studies were found to have a similar decreasing metals concentration trend moving towards the tidal inflow (M. Soto-Jimenez & F. Paez-Osuna, 2001). Since the Los Cerritos Wetlands are tidally influenced, it is plausible that heavier sediments are deposited toward the mouth while finer grained sediments remain suspended in the water column until they are deposited in the supratidal, rear portions of the slough. This might be possible due to differences in flow velocity from the mouth of the slough to the back of the slough. The combination of the relatively infrequent tidal flooding of the back of the slough along with the accumulated fine sediment particles makes the rear portion of the marsh a large "sink" for metals. The source of the metals pollution is presumed to be the Los Cerritos Channel, which has a direct input into the Slough, being located at its mouth.

Conclusions

Grain-size (texture) of the soil controls drainage, nutrient content, cation exchange capacity, organic matter accumulation (Callaway et al., 2001), and heavy metal sorption. The Los Cerritos Degraded Marsh (LCD) is comparable to the slough. The grain size of the samples from the degraded marsh were not as fine as the samples taken from the slough, meaning the sediment may not hold water as well as the slough. Nevertheless, the LCD has significant amounts of clay, 15-45%, which makes it an adequate tidal marsh site. Silt has the ability to hold water more readily than sand, so this wetland potentially could be restored given the grain size of the soils.

In regards to the samples taken from the supra and inter-tidal areas of the slough, the grain size appears to be what is expected for wetlands. The samples taken from the upper slough have coarser grains than those taken from the middle slough. The middle slough appears to contain more mud within the samples as compared to the upper slough.

The samples taken from Callaway and Zedler marsh appear to be coarser than all other samples taken. It appears that this wetland may require more intensive restoration efforts due to the coarser grains. The coarser grains would need to be removed and replaced with finer silt and mud sediment to be brought in, for the soil to hold water. The samples taken may have hit an undesirable area which could have altered the results. One sample was taken from each marsh so further samples should be taken in order to verify the grain size of the two marshes.

The mineralogy of Los Cerritos wetlands is representative of what one would expect to find; it corresponds to that of the San Gabriel River Watershed and the Los Angeles basin. Callaway marsh is the only difference with at least the top 9cm having contamination. No detectable natural minerals were present because of the heavy chemical waste. It is possible that waste was buried at this site and only occupies a very shallow level. The 12-15cm sample's mineralogy returned to normal. To see if the studied sample was not an isolated occurrence, further studies must be done to confirm widespread synthetic chemical presence. Any restoration effort, as seen from the single sample in this study, may require meticulous cleaning of Callaway marsh.

The different levels of organic carbon content at the Degraded Marsh and at Callaway and Zedler can be explained by two different processes that will likely take place. The Degraded Marsh on average comes fourth and fifth, just after parts of the Slough. This suggests that it has enough organic matter to become viable to the same level of the Slough. It is encouraging since the average is above parts of the Slough's averages. As stated before in the discussion, the Slough functions differently than the Degraded Marsh would function. This may prove to be an asset after more is known about definitively restoring wetlands. The levels of organic matter in the Degraded Marsh would create a good source of replenishment for the first layer. It could also provide an extra filtration system because it improves the water quality by storing and transforming pollutants. The only reservation in the viability of the Degraded Marsh would be the sample that was the closest to the street. This sample contained less organic matter than both of the other samples by about 1% (Fig. 5b). With the stimulation of the other organic matter and by storing carbon from the atmosphere, it will help to reduce the pollution that it incurs from its close proximity to the street. All of these factors create a preliminary conclusion that the Degraded Marsh is viable up to the level of the Slough.

The Callaway and Zedler sites appear to be semi-viable. These two sites mirror the processes of the Slough. Although in the two sites the average organic carbon content is low in comparison to the other samples at 7.31% (Fig. 5b) for Callaway and 4.92% (Fig. 5b) for Zedler, both sites have a high content of organic carbon on the 0 - 3cm layer. The amounts at the 0 to 3 cm layer are 14.69% (Fig. 5c) for Callaway and 11.36% (Fig. 5c) for Zedler. The organic carbon content at the top that stimulates the site is high and compared to some samples of the Slough higher. There is a water source which makes them more viable but the lack of organic carbon content could lead to the underproduction of the sites. The preliminary conclusion is that the amount of organic matter is not enough to lead to a completely viable wetland. There are additional sources that are also impeding the production of these sites.

The salinity found in these locations supports the notion that these soils can support life. If the Degraded Marsh areas were once again flooded by water, they have a salinity that is consistent with soils which crops are grown upon. This would be a viable area to restore. Other sites that can be restored in the salinity context would be the Zedler and Callaway wetlands. There is not enough salt to hinder the growth of multiple species of vegetation and animal life.

The Slough has a higher level of salinity than the other three sites. The salinity level may be too high for a large range of plants to inhabit the area. The ocean may create a salinity level that is too high to leave vegetation undisturbed. Only highly tolerable plants are able to grow.

In all sites tested in this survey, none of the salinity tests would supports a freshwater marsh. Only a brackish or saltwater marsh would be possible if the areas were to be fully restored. Both Callaway and Zedler marshes have a salinity level which would possibly support a brackish marsh (Table 4.4). Future testing in the same general area is needed to compare these results. Also, testing at other wetland locations would be beneficial to more precisely examine these findings. This test takes a little amount of time and is relatively easy to perform. Doing tests on many samples can be done in a short amount of time.

When looking at the concentrations of the various metals, a comparison can be made with sediment quality guideline values (Long and others, 1995) of the effects-range-median. (ERM) When metals concentrations exceeded the ERM values, the observed adverse biological effects increased to 60%-90%. In our results, cadmium and silver exceed ERM values across all samples. It also appears that most lead values across sites and profiles exceed the ERM values. For nickel, the supratidal back, supratidal middle and degraded river at 0-3cm were all found to exceed the ERM guideline values. Future research teams should research the toxicity of the sediments by using amphipod bioassays along with measuring both pore water and overlying water for possible metals content. In addition to toxicity testing, future research could also include studies focusing on turbidity differences between the mouth of the slough and the rear (water column samples) as well as analyzing the metals content of fine grained sediments within the water column that may be pulling metals pollutants from the incoming water (both from tidal influx and the Los Cerritos Channel).

With the baseline study completed, future ES/P students of the Hydro/Geochem Teams can use the data found in our project in theirs. More precise studies will also be able to be developed with straight forward questions and objectives to achieve a goal. From what was done, it is plausible that some restoration attempts can be put into place for the degraded marsh along with Callaway and Zedler, although more research needs to be done to help with final decisions.

References

Boggs, S. (2000). Principles of Sedimentology and Stratigraphy, Third Edition

Callaway et al., 2001

Dean, W.E. Jr., 1974. Determination of carbonate and organic matter in calcareous sediments and sedimentary rocks by loss on ignitions.

Dierks, S. 1994. Arsenic Selenide Material Safety Data Sheet. Electronic Space Products International. http://www.espimetals.com/msds's/arsenicselenide.pdf

EPA Method 3052, Microwave assisted Acid Digestion of Siliceous and organically based Matrices

Heiri, Lotter, & Lemcke, 1999. Loss on ignition as a method for estimating organic and carbonate content in sediments; reproducibility and comparability of results.

Kahn, C.E. Jr. 2007. BioInformatics Glossary: 5-Bromouracil http://big.mcw.edu/display.php/755.html

Kelly, J.F. 2005. A Brief History of SiC. University of London http://img.chem.ucl.ac.uk/www/kelly/moissanite.htm

Klein, C., Hurlbut, C.S. Jr. 1985. Manual of Mineralogy. John Wiley & Son.

Kotuby-Amacher 1997. Salinity and Plant Tolerance.

Lewis, D.W. and McConchie, D. 1994. Analytical Sedimentology. Medical College of Wisconsin

M. F. Soto-Jimenez & F. Paez-Osuna. 2001. Distribution of and Normalization of Heavy Metal Concentrations in Mangrove and Lagoonal Sediments from Mazatlan Harbor (SE Gulf of California). *Estuarine, Coastal and Shelf Science* 53, 259-274.

M.G. Menon, R. J. Gibbs, A. Phillips. 1998 Accumulation of muds and metals in the Hudson River Estuary turbidity Maximum. Environmental Geology 34, 214-222

Gibbs RJ (1977) Transport phases of transition metals in the Amazon and Yukon rivers. Geol Soc Am Bull, 88:829-843

Long, E. R., D. D. MacDonald, S. L. Smith, and F. D. Calder. 1995 Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. *Environmental Management* 19(1):81-97

Mitsch and Gosselink. 1986. Wetlands. New York: Van Nostrand Reinhold Co.

Soil Survey Staff. 1993. Soil survey manual. United States Department of Agriculture.

Tanji, K.K. (ed.). 1990. Agricultural salinity assessment and management (Manual No. 71).

United States Department of Agriculture, 2007. Soil Organic Matter. www.nrcs.usda.gov.

Appendix C

Profile Metals Data

Profile 0-3

Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Supratidal Back	0.78660792	87.1617	62.4579	17.2339	79.0803	45.2468	139.533	16.3221
Supratidal Middle	0.329803897	51.065	52.3835	11.4146	52.495	29.6623	96.7655	10.455
Supratidal Mouth	0.106866671	21.2965	20.5693	9.01166	13.8754	20.4361	57.9816	6.75339
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Intertidal Back								
Intertidal Middle	0.815679646	49.0324	65.9533	14.3862	33.8221	80.2185	252.505	13.6195
Intertidal Mouth	0.536915384	49.7853	48.6499	13.9074	30.5698	46.2516	116.897	15.5246
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Subtidal Back	0.551209644	44.0479	56.5015	14.801	33.0096	64.1524	214.38	13.0849
Subtidal Middle	0.696361055	44.7115	53.976	14.4129	29.8629	52.5671	157.15	12.5836
Subtidal Mouth	0.35952962	32.9035	41.9177	11.8916	19.2385	41.6184	121.261	8.90682
Degraded River								
Degraded Middle	0.89204883	76.6891	69.8977	16.1243	67.1763	44.8335	161.032	14.0542
Degraded Street	0.377956176	39.1184	36.555	12.3304	31.9112	34.4872	86.1331	9.6432

Profile 0-3

Sample Location	Se (ppm)	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Supratidal Back	3.196866561	91.344	9.16659	7.48627	18.229	7.9812	7.88548	10.902	418.459
Supratidal Middle	3.824014009	73.7873	8.26465	7.18659	17.5143	8.14542	7.72364	81.572	375.912
Supratidal Mouth	0.862731321	165.142	8.07135	7.28539	17.7825	7.95098	7.77475	59.2645	388.314
Sample Location	Se (ppm)	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Intertidal Back									
Intertidal Middle	1.786106575	28.2031	10.4043	7.60005	18.4035	9.08019	8.05213	140.208	345.878
Intertidal Mouth	1.631137637	65.0994	11.3417	7.29712	17.653	8.29909	7.8214	193.503	336.927
Sample Location	Se (ppm)	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Subtidal Back	1.043210553	25.6429	10.2544	7.68838	18.7097	8.81546	8.13976	142.804	338.733
Subtidal Middle	0.792219009	23.3026	8.82955	7.1647	17.4474	8.15614	7.61012	159.031	329.148
Subtidal Mouth	0.819738227	17.6348	8.08719	7.22837	17.6078	8.09933	7.656	132.711	349.244
Sample Location	Se(ppm)								
Degraded River									
Degraded Middle	1.100340546	102.357	8.22771	7.29629	17.7657	8.27889	7.81295	1863.72	366.636
Degraded Street	0.839181284	97.937	7.74547	6.73731	16.4935	7.55581	7.25341	399.445	327.416

Profile Metals Data 6-9cm

Profile 6-9

Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Supratidal Back	0.836098365	51.2056	62.7712	15.9788	33.4444	43.0816	113.897	12.3982
Supratidal Middle								
Supratidal Mouth	0.144169917	20.3322	12.3147	9.38653	11.2584	18.5181	44.2541	4.15356
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Intertidal Back								
Intertidal Middle	0.338649084	31.8245	38.3482	11.7288	17.5057	25.4389	66.9903	9.70831
Intertidal Mouth	0.72984327	48.9131	46.6062	15.7864	34.0991	43.052	112.758	13.4651
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Subtidal Back	0.684120404	49.3174	55.7084	16.7093	34.1773	49.9194	141.696	16.8418
Subtidal Middle	0.793115835	51.0631	62.7688	16.114	33.0496	53.931	155.748	15.3918
Subtidal Mouth								
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Degraded River	0.452297346	47.6198	43.8564	13.3841	47.5069	31.8105	92.153	11.2151
Degraded Middle	0.360788423	31.2954	29.7151	12.106	20.5644	28.5982	65.2717	9.43843
Degraded Street	0.413550707	42.3858	36.402	13.2707	33.4083	33.2776	87.3807	9.72642

Profile 6-9

Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Supratidal Back	1.610594042	130.652	8.58017	7.57979	18.4397	8.31232	8.1097	216.669	374.45
Supratidal Middle									
Supratidal Mouth	0.583372713	22.3542	8.00155	7.11611	17.3547	7.73054	7.62032	109.316	374.991
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Intertidal Back									
Intertidal Middle	0.691214107	16.2517	8.11577	7.29331	17.7867	7.99127	7.7933	122.588	374.471
Intertidal Mouth	1.246628391	79.5674	10.6235	8.12717	18.3349	8.47768	8.08725	443.171	355.365
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Subtidal Back	0.704350189	71.9946	9.17706	7.39206	18.0711	8.30516	7.90805	193.65	328.945
Subtidal Middle	0.94653762	35.7939	8.99407	7.54804	18.4125	8.55863	8.05073	186.207	349.049
Subtidal Mouth									
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Degraded River	0.655885998	76.1717	8.35627	7.38696	18.0258	8.21599	7.9094	1135.38	365.623
Degraded Middle	0.529440392	50.6265	7.97142	7.02092	17.1725	7.71095	7.48084	175.312	347.048
Degraded Street	0.692368856	86.6119	8.41997	7.43854	18.2042	8.2248	7.97489	379.379	364.325

Profile 12-15

report name	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Supratidal Back								
Supratidal Middle	0.301998367	32.7253	33.4133	13.3918	22.6845	31.6428	85.2321	10.1373
Supratidal Mouth	0.050462764	19.3753	23.419	8.55461	7.57818	17.5267	25.7353	6.8007
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Intertidal Back	1.163871642	68.7291	74.0347	21.4775	46.5596	54.9486	137.903	27.6824
Intertidal Middle	0.530476125	44.7868	50.7661	13.0048	27.9571	35.789	101.639	11.8815
Intertidal Mouth	1.183451303	63.0117	65.5894	17.9106	39.8944	49.0915	124.694	17.8128
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Subtidal Back	0.565594079	42.1056	42.8912	15.6475	30.7545	46.2507	136.452	14.3691
Subtidal Middle	0.661729854	50.2337	57.8689	16.6402	35.1403	59.9941	165.596	20.1649
Subtidal Mouth	0.271827497	26.9048	25.3771	11.3671	17.7333	35.8807	104.642	6.75188
Sample Location	Be (ppm)	V	Cr	Co	Ni	Cu	Zn	As
Degraded River	1.034826941	58.2833	68.3029	17.723	38.3489	47.9142	114.876	16.468
Degraded Middle								
Degraded Street	0.636487151	52.3087	47.0182	14.1487	38.3408	35.1957	98.7508	11.5931

Profile 12-15

report name	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Supratidal Back									
Supratidal Middle	0.614262711	24.3193	8.27614	7.30797	17.8342	8.04707	7.83745	178.462	357.323
Supratidal Mouth	0.55717098	23.7284	7.97257	7.27131	17.7467	7.84521	7.76135	82.3715	393.791
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Intertidal Back	1.926678385	84.3997	10.4457	7.23569	17.6245	8.18928	7.89931	210.732	338.956
Intertidal Middle	0.844817554	20.1038	8.44717	7.30031	17.818	8.14191	7.81406	148.492	361.085
Intertidal Mouth	1.011334973	69.7659	9.02437	7.1748	17.3873	8.04507	7.67339	249.176	331.271
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Subtidal Back	0.506158005	83.6001	8.54385	7.21699	17.7341	8.10103	7.78158	253.288	332.885
Subtidal Middle	0.714077813	107.129	9.13403	7.62255	18.7831	8.66486	8.21407	227.582	356.065
Subtidal Mouth	0.596206354	17.7807	8.07807	7.1628	17.4483	7.9621	7.59852	130.635	341.519
Sample Location	Se	Sr	Mo	Ag	Cd	Sn	Sb	Ba	Tl
Degraded River	1.233092712	90.8979	8.89627	7.31579	17.9927	8.21866	7.85575	240.666	338.786
Degraded Middle									
Degraded Street	0.693599533	77.2316	8.27932	7.35332	17.9935	8.22333	7.89469	472.863	363.457

ppm	Hg	Pb
LS1 0-3 D	314.3938554	460.5697
LS1 0-3	364.7392044	488.3746
LS1 6-9	309.862034	472.6479
LS1 12-15	272.7134317	462.3943
LS1 12-15 D	342.6043952	476.7851
S1 MID 12-15	426.9037093	>27.5 ppm
S1 UPPER 0-3	682.8865057	480.7123
S1 UPPER 6-9	592.0607411	>27.5 ppm
LS2 0-3	356.1221193	>27.5 ppm
LS2 6-9	354.1452789	>27.5 ppm
LS2 12-15	140.1377544	486.0504
S2 MID 0-3	363.3806763	481.4677
S2 MID 6-9	575.5404536	>27.5 ppm
S2 MID 12-15	425.8926456	>27.5 ppm
S2 UPPER 0-3	543.5029932	463.0932
S2 UPPER 12-15	432.3582682	>27.5 ppm
LS3 0-3	478.7961645	>27.5 ppm
LS3 6-9	278.6661983	>27.5 ppm
LS3 12-15	213.5153104	>27.5 ppm
S3 MID 0-3	399.734266	463.7064
S3 MID 6-9	454.5552589	>27.5 ppm
S3 MID 12-15	497.8905259	>27.5 ppm
S3 UPPER 0-3	611.2611124	>27.5 ppm
S3 UPPER 6-9	587.6205261	>27.5 ppm
S3 UPPER 12-15	609.4335767	93.08052
LCDR 6-9	534.058173	475.5825
LCDR 12-15	562.2191104	>27.5 ppm
LCDM 0-3	548.0729126	468.1345
LCDM 6-9	558.0420525	>27.5 ppm
LCDS 0-3	503.2479166	432.8363
LCDS 6-9	560.4238061	478.3669
LCDS 12-15	553.4450788	>27.5 ppm
ZEDLER 0-3	508.2242758	485.6652

FIGURES

Fig. 4.7 OM on map/

Table 2. Mineralogy bulk (# occurrences). Table 4.2 shows the Table 3.   Mineralogy fines. Table 4.3 shows the number of occurrences of each mineral found in the fine grain sized samples

Fig. 7 Organic Carbon Content on Map of LCW
Fig. 8 Salinity on Map of LCW

TABLES
Table 2. Mineralogy bulk (# occurrences)
Table 3.   Mineralogy fines
Table 9 ERM Sediment Quality Guideline Values

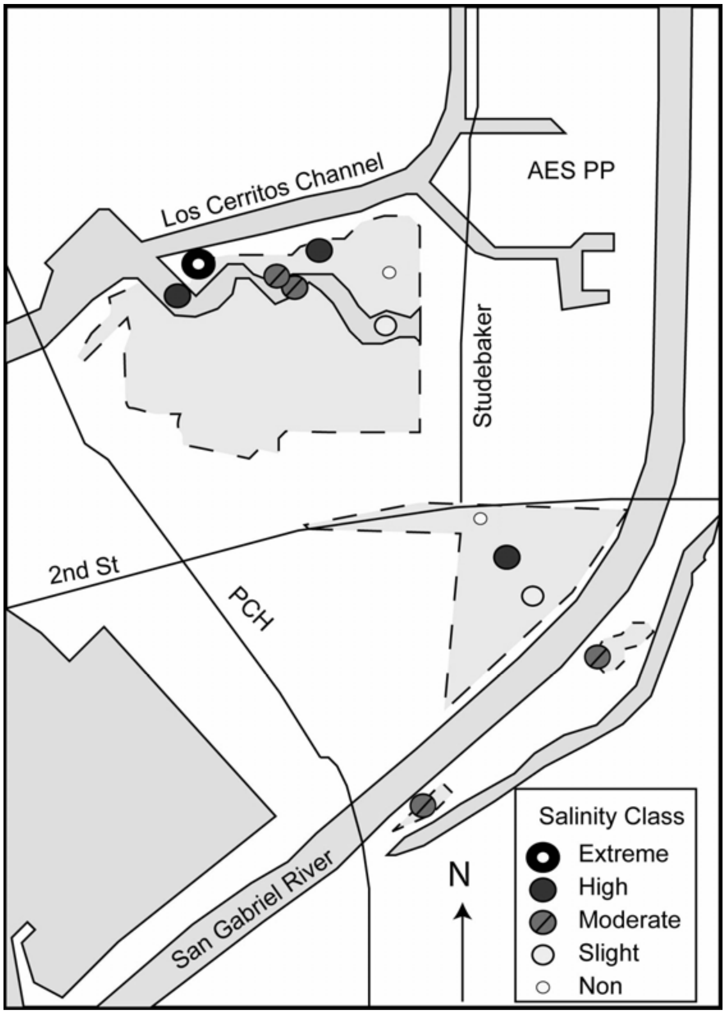


Fig. 4.8 Map of the Los Cerritos Wetlands Complex showing the distribution of average soil salinities for each core, except MS2 and MS3. Increasing size of circles corresponds with increasing salinity. Ranges for individual salinity classes are listed in Table 4.6.

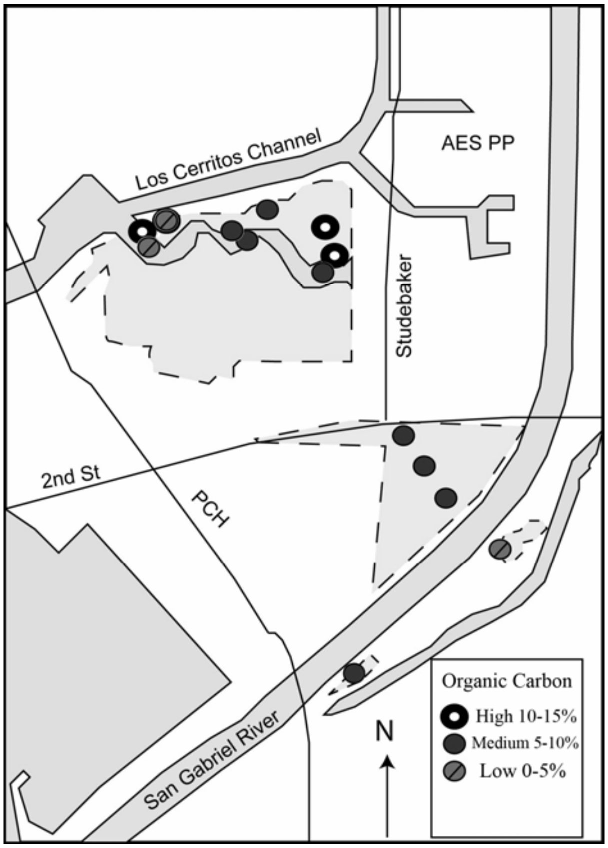


Fig 4.9 Map of the Los Cerritos Wetlands Complex showing the distribution of average organic carbon content for each core. Increasing size of circles corresponds with increasing organic carbon content.