Vegetation of the Hoffman Marsh Post Restoration of 1984

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Introduction

Hoffman Marsh is an intertidal salt marsh, located in the southern-most part of the City of Richmond (Figure 1). The 40-acre Marsh is part of the original Bay margin. Such areas as this are rare, because over 85 per cent of the Bay's marshes and tidal flats have been filled in over the last hundred years.

Hoffman Marsh has also experienced modifications due to landfilling around its perimeter. Construction of a dike to support a sewer line resulted in the isolation of the southern portion of the Marsh (Figure 2). This southern section, the "study site," is the area on which I will focus my study. The remaining portion of the Marsh, the "main marsh," is connected to San Francisco Bay by a 15-foot wide channel inlet. The channel provides

Due to state and federal law requiring legal compensation or "mitigation" for the development of environmentally significant land, the California Department of Transportation (CalTrans) in 1984 did some restoration work in the southern portion (study site) of the Hoffman Marsh, as compensation for the widening of Highway 17 (now I-580) (Craig, 1985). The restoration was intended to increase water circulation through the study site. Because of unforeseen problems, only portions of the restoration project were completed.

Craig (1985) studied the vegetation in the southern part of the Marsh prior to the rehabilitation project. My study will be a follow up to Craig's. By identifying the species present today and calculating their frequency, I hope to identify the changes, if any, that have occurred to the flora since the restoration project, using Craig's study as the basis for my comparison. It is my hope that through this follow-up project the success of the mitigation process can be evaluated, and future mitigation cases can be guided by these assessments.

Past Studies

The first substantial source of data about Hoffman Marsh was an environmental impact analysis for the widening of Highways 17 and 80 along the Richmond-Albany shorelines (URS,

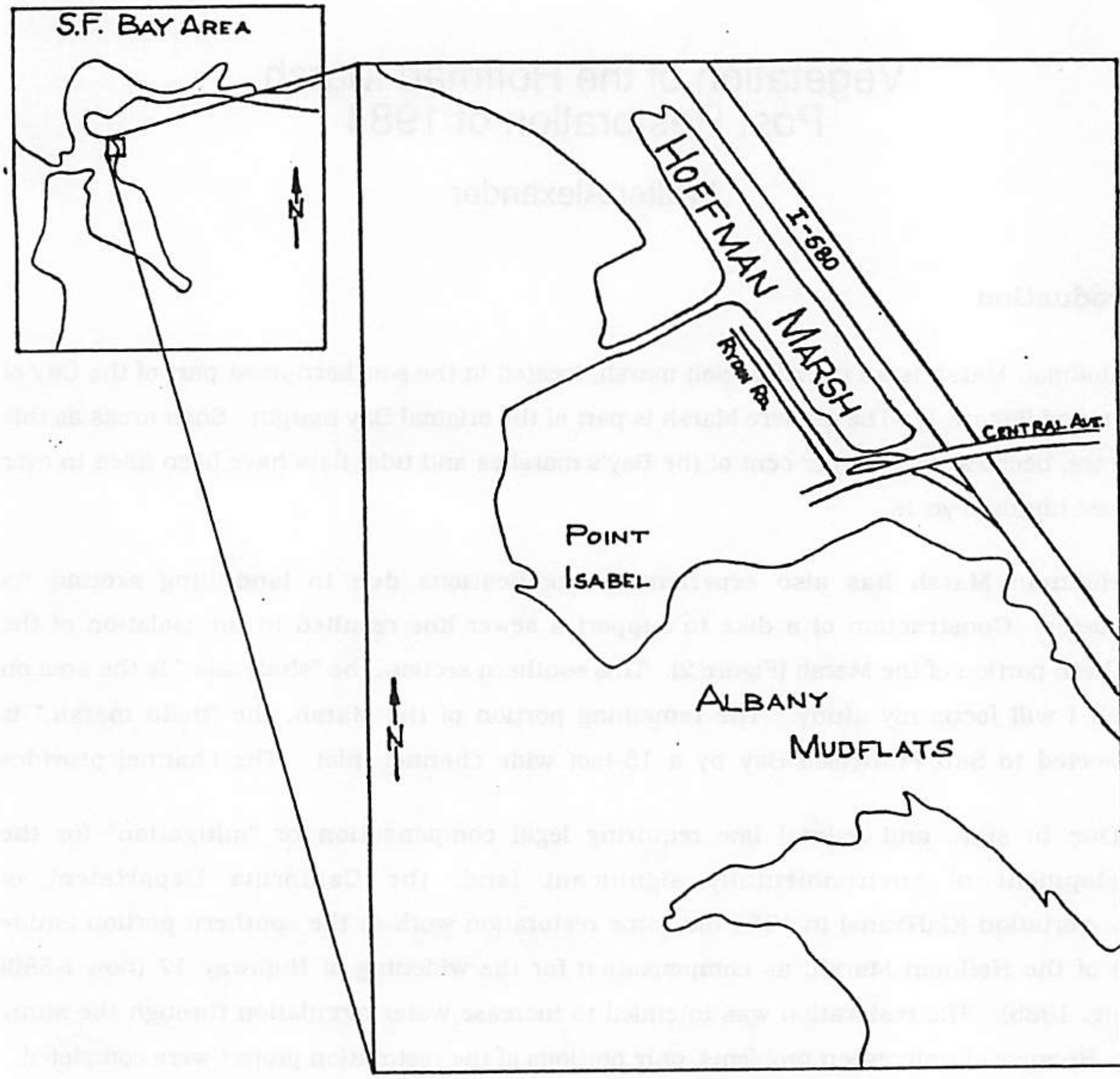

Figure 1. Regional setting of Hoffman Marsh
Base Map: URS, (1973).

1973). In this study both plant and animal life were examined. Interestingly, the results that were obtained in this 1973 analysis are similar to those obtained in the present study.

The 1984-85 Environmental Sciences Senior Seminar devoted a section of its report to the Hoffman Marsh. Their research covered the time prior to the commencement of the actual restoration work. Siegel (1985) measured the dissolved oxygen, pH, turbidity, and temperature of different sections of the southern part of the Marsh (Siegel, 1985). Siegel later did a follow-up report in which he identified the differences between the tidal inflow in the two sections of the Marsh (Merrill and Siegel, 1986). His intention was to obtain a base for comparison after the mitigation was complete. Craig's (1985) vegetation analysis measured the per cent frequency and coverage of the different marsh species. Craig's report is the basis for my comparison.

The 1988-89 Environmental Sciences Senior Seminar is again studying similar aspects of the Marsh. In addition to my vegetation study, Austin (this report) conducted a water quality study and Lockwood (this report) monitored bird life in the Marsh. These updated studies will help determine the mitigation's success and could possibly set a precedent for future

Background

When the Europeans first reached the California coast, the tidal marshes of San Francisco Bay and the Sacramento-San Joaquin Delta covered over 2200 km^2 (Josselyn, 1983). Today

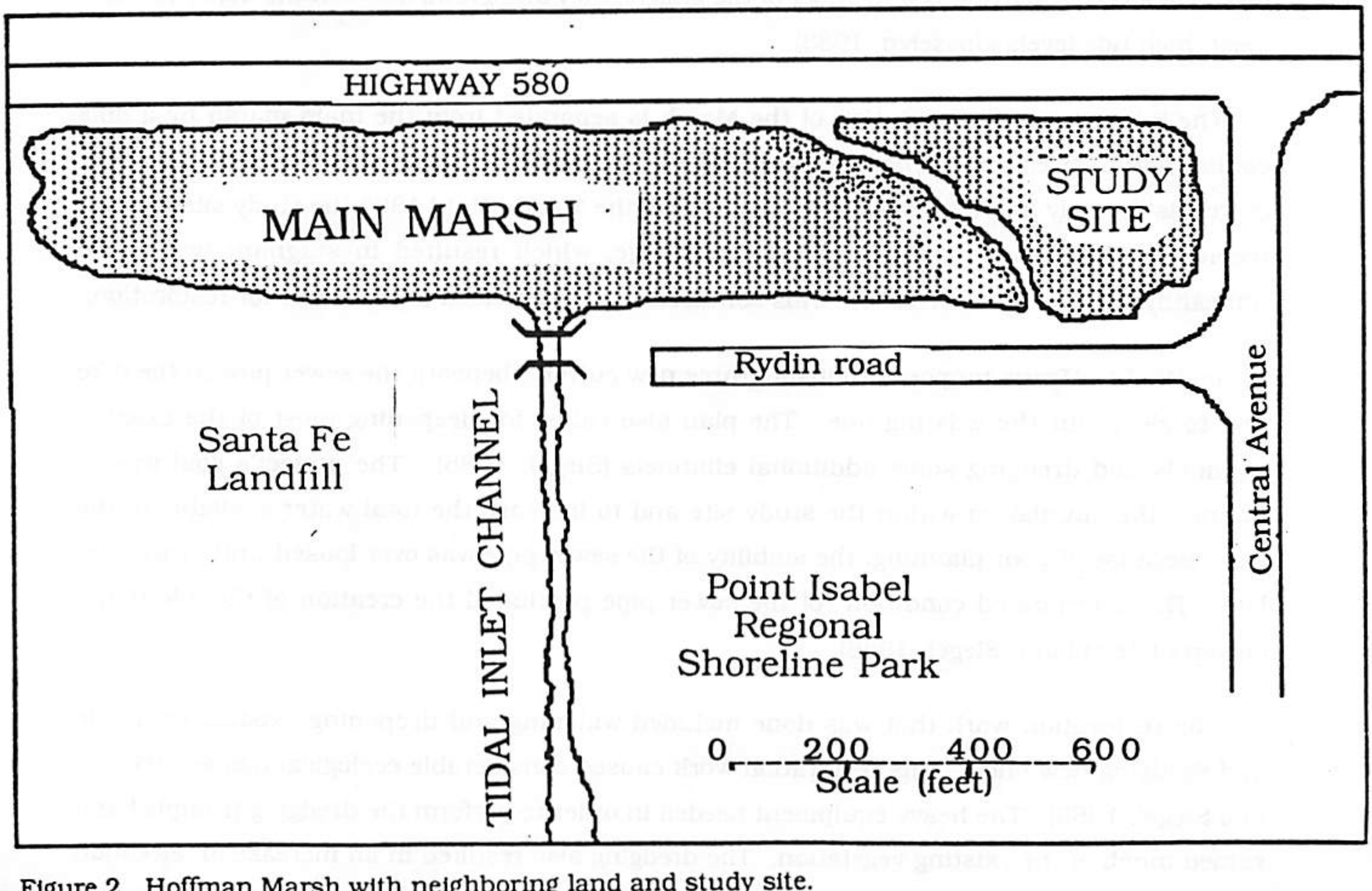

Figure 2. Hoffman Marsh with neighboring land and study site.
Source: Adapted from Siegel (1985).

the tidal marshes cover less than 10 per cent of that area. The remaining marshes are a key element of the estuary ecosystem. In addition to the many species of birds that are found in marsh habitats, small invertebrates and fish use the marsh as a home as well as a breeding ground (Murry and Horne, 1979).

Tidal marshes are characterized by vascular plants that are found between the mean low water level and the extreme high water level (Josselyn, 1983). Hoffman Marsh's elevation is generally above mean high water level (Merrill and Siegel, 1986). The vegetation in Hoffman Marsh is extensive, providing a home for many different species. Salicornia virginica (common pickleweed) is by far the most common species in the Marsh, with Distichlis spicata (salt grass) and Spartina foliosa (Pacific cordgrass) also being fairly extensive. The latter is only present in the main marsh. Salicornia is a perennial and forms extensive, intertwining above-ground branches (Josselyn, 1983). Salicornia predominantly occurs between the mean high tide and the mean higher high tide levels. Distichlis is a low perennial which tends to grow in clumps or bunches and is found mainly between mean higher high tide and extreme high tide levels. Spartina is a member of the grass family and grows between the mean tide and mean high tide levels (Josselyn, 1983).

The 7.5-acre southern section of the Marsh is separated from the main marsh by a dike containing a sewer pipe owned by Stege Sanitation District (Merrill and Siegel, 1986). A 2' culvert is the only link between the two sections of the Marsh. Until 1984 the study site was not receiving an adequate amount of tidal exchange, which resulted in stagnant water and unhealthy vegetation (Hay, 1985). This southern section provided an ideal site for restoration.

In 1984 CalTrans proposed to install three new culverts beneath the sewer pipe in the dike and to clean out the existing one. The plan also called for deepening most of the existing channels and dredging some additional channels (Siegel, 1985). The project's goal was to improve the circulation within the study site and to increase the total water available to the site. Because of poor planning, the stability of the sewer pipe was over looked until it was too late. The deteriorated condition of the sewer pipe precluded the creation of the additional culverts (Merrill and Siegel, 1986).

The restoration work that was done included widening and deepening existing channels and dredging new ones. This restoration work caused considerable ecological damage (Merrill and Siegel, 1986). The heavy equipment needed in order to perform the dredging trampled and ruined much of the existing vegetation. The dredging also resulted in an increase in elevation in many parts of the Marsh. Much of the dredge spoils were left in piles along the Marsh.

CalTrans later tried to restore the original elevation but this was not completely successful and resulted in additional scars to the Marsh (Siegel, 1985).

Methodology

My initial trips to the Marsh were dedicated to identifying the different plant species occupying the study site, with the aid of an identification book (Faber, 1982). I limited myself only to the vegetation on the Marsh itself and disregarded the upland perimeter plants. After all species had been identified, the study site was divided into two transects to determine the relative abundance of each species. The dike served as the starting point for both transects. The transects extended to the southern end of the study site, running parallel to the freeway (Figure 3). A string was pulled tightly across the study site to align the transects. The transect sites were located in an area similar to Craig's (1985) transects.

A 0.25 m^2 wood frame was subdivided into 25 100 cm^2 sections. The frame was placed on alternating sides of the transect line at one-meter intervals. Five of the 100 cm^2 sections were surveyed at each location, starting from the dike and moving south along the line. In transect A 115 sections were sampled. Transect B, which lay closer to the freeway, contained 170 sampled sections. Transect B had more sections than transect A because transect B was much longer. The sections to be surveyed at each location were chosen randomly prior to going into the field. A record was kept for each section, noting which species were present and which species was dominant in that particular section. To determine which species was dominant for each section I carefully estimated the area that each species occupied for the section in question. The species which covered the largest area was considered dominant. The survey for transect A was conducted on January 27, 1989. The procedure was again conducted for transect B on February 5, 1989.

After the data had been compiled, two calculations were made. First, the total frequency of the species was determined. Total frequency is calculated by dividing the number of sections in which the species occurs by the total number of sections sampled, including sections without vegetation. The second calculation determined the percent domination of a species. The percent domination of a species is calculated by dividing the number of sections in which a species was dominant by the total number of sections sampled, Again, sections in which no vegetation was present were included in the total number sampled. These calculations differ somewhat from those conducted by Craig (1985). The reason for the discrepancy will be discussed below.

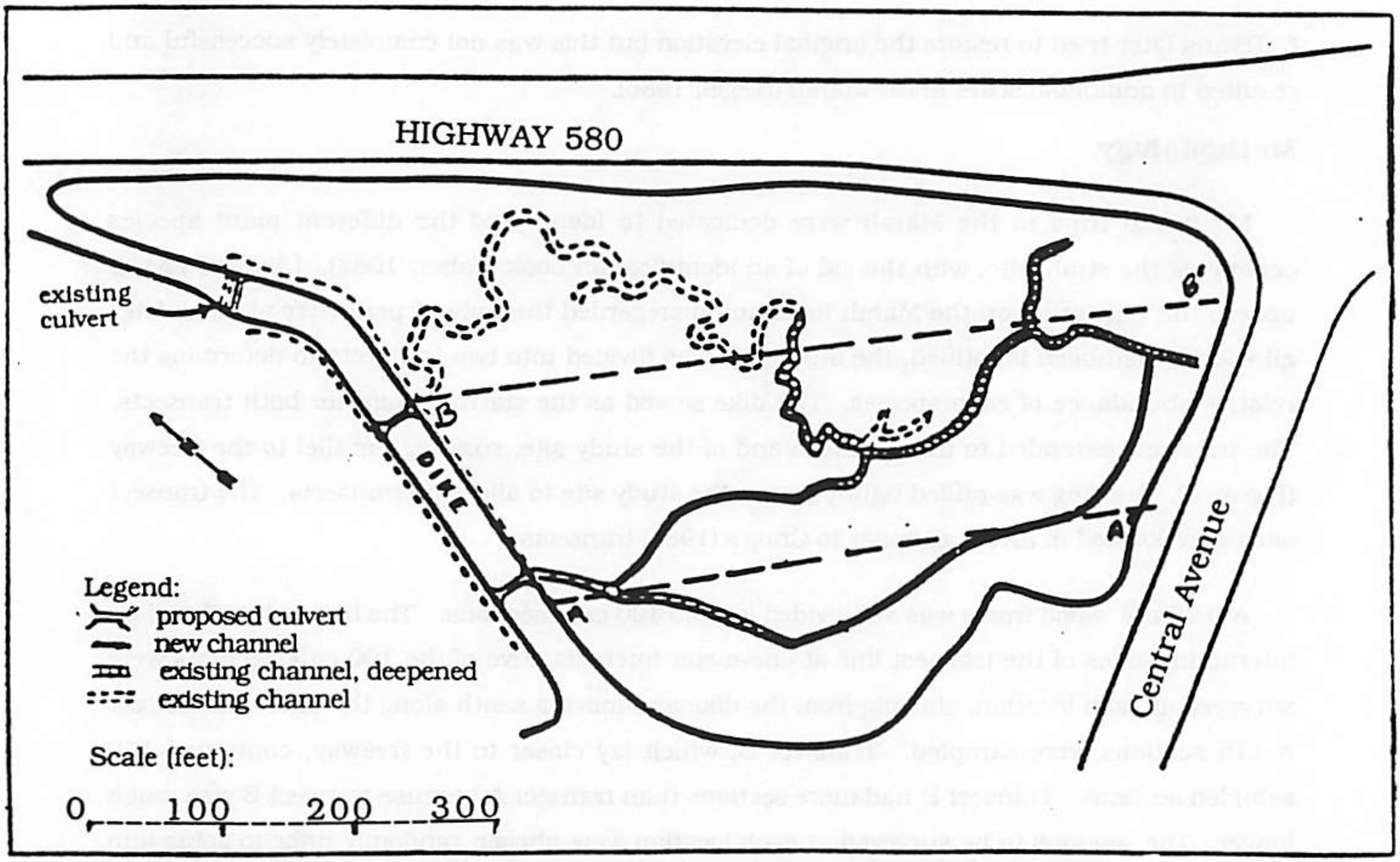

Figure 3. Hoffman Marsh Study Site, showing Restoration Features and Sample Sites.
Source: Adapted from CalTrans (1984).

Results

From my initial species identification field work, I was able to identify eight species which inhabit the study site. Only five of these species, however, occurred along my transect lines: Salicornia virginica, Distichlis spicata, Grindelia humilis (marsh gumplant), Cuscuta salina (salt marsh dodder), and Limonium californicum (marsh rosemary) (Table 1). Three other species were identified but did not occur along the two transects: Cotula coronopifolia (brass-buttons), Frankenia grandifolia (alkali heath), and Jaumea carnosa (Jaumea). In the study site these three species were very scarce and scattered.

Salicornia virginica almost completely dominates the Hoffman Marsh, in both the study site and the main marsh. Except for small clumps of other vegetation, Salicornia completely covered over the barren scars left by CalTrans' heavy equipment. As noted earlier, the study site did not harbour Spartina foliosa.

Species Present in the Study Site

Salicornia virginica (Pickleweed)
Distichlis spicata (salt grass)
Grindelia humilis (marsh gumplant)
Cuscuta salina (salt marsh dodder)
Limonium californicum (marsh rosemary)
Cotula coronopifolia (brassbuttons)
Frankenia grandifolia (alkali heath)
Jaumea carnosa (Jaumea)

Table 1: Species inhabiting the study site.

Table 2 charts the number of sections in which a species is present along a given transect, as well as the number of sections in which it was the dominant species. The table also charts the per cent frequency and per cent dominance of a species for the two transects. The highest per cent frequency and per cent dominance of Salicornia occurred in transect B; 92.9 per cent frequency and 77.1 per cent dominance in the 170 sections sampled. In transect A Salicornia had a per cent frequency of 84.3 per cent and a per cent dominance of 69.6 per cent in the 115 sections sampled. Distichlis spicata was the second most frequent and dominant species along both transects. In transect A, Distichlis had a per cent frequency of 33.9 per cent and a per cent domination of 18.2 per cent, which were the highest for this species. Along transect B Distichlis had a per cent frequency of 18.2 per cent and a per cent dominance of 11.8 per cent. Interestingly, Grindelia, an upland plant, was the next most abundant species. In transect A Grindelia had a per cent frequency and per cent dominance of 7.0 per cent, the highest numbers of the two transects for this species. In transect B both per cent frequency and per cent dominance for Grindelia were 4 per cent. In transect B Cuscuta had a per cent frequency of 8.8 per cent but was only dominant 2.9 per cent of the time. In transect A Cuscuta had a frequency of 4.3 per cent but was never dominant. Limonium did not occur at all in transect B but had a per cent frequency and per cent dominance of 1.7 per cent in transect A.

Sampling Date	Species	Sections Present	Per cent Frequency	Sections Dominant	Per cent Dominant
A 1/27/1989	Salicornia virginica	97	84.3	80	69.6
	Distichlis spicata	39	33.9	21	18.3
	Grindelia humilis	8	7.0	8	7.0
	Cuscuta salina	5	4.3	0	0
	Limonium californicum`	2	1.7	2	1.7
	no vegetation	4	3.4	4	3.4
B 2/5/1989	Salicornia virginica	135	92.9	131	77.1
	Distichlis spicata	31	18.2	20	11.8
	Grindelia humilis	4	2.3	4	2.3
	Cuscuta salina	15	8.8	5	2.9
	Limonium californicum	0	0	0	0
	no vegetation	10	5.9	10	5.9

Table 2. Per cent frequency of each species, number of sections in which species is present, number of sections in which species is dominant, and per cent dominance of each species.

Discussion

The purpose of this study was to determine if there had been any change in the flora at the study site since the restoration project of 1984, and from this, to evaluate the success of the mitigation.

Craig's (1985) study was intended to be the basis of this comparison, but unfortunately some differences between his methods and mine make a detailed comparison difficult. However, some comparisons and distinctions can be made from the data collected in both studies. First, however, I will identify the discrepancies between the two studies.

In Craig's research the study site was divided into three transects. However, two of the transects shared the same line, one extending further along the line than the other. I believe this was done because of the restoration that was occurring at that time. I felt no need to have an additional transect along the same line, and therefore only had two transects.

Per cent frequency was calculated in both studies. However, Craig calculated the relative frequency, which is the number of sections in which a particular species occurs divided by the number of sections in which there is vegetation. I, on the other hand, calculated the total frequency, which is similar except that the denominator is the total number of sections sampled, including those with no vegetation. Craig probably calculated relative frequency

Furthermore, instead of calculating per cent domination, Craig calculated per cent coverage. Because he did not explain his method for this calculation, I have assumed that the two calculations are roughly equivalent. Craig only listed the per cent frequency and per cent coverage for the dominant two species in each transect. Because the per centages of the less common species were not recorded, it was not possible to identify changes in the growth patterns of these species .

As a result of these problems, a strict comparison between the two projects is not possible. There are, however, other comparisons to be made. The dominance of Salicornia was the most obvious similarity between the two studies. In addition, Spartina foliosa did not grow in the study section at the time of either project, nor did it in 1973 when the environmental impact analysis was conducted (URS, 1973). The eight species which I identified in the study site were also identified by Craig. The only difference in the two studies was Raphinus sativa (wild radish), which was not present during my project but was reported by Craig. I suspect that the absence of Raphinus during my field work was due to the months in which my work was conducted. My field work was done in January and February, whereas Craig's was conducted in October and March.

The most obvious difference between the two studies is the amount of vegetation coverage. Hoffman Marsh is now totally covered in vegetation, except for a few small salt pans. In 1985 there were several areas where there was no vegetation. Comparing Craig's per cent coverage to my per cent dominance, if the assumption of their equivalence is correct, shows a definite decline in Salicornia's per cent dominance. Salicornia's dominance has declined from 92 per cent to 69.6 per cent along transect A and from 95 per cent to 77.1 per cent along transect B. At the same time, the per cent dominance of Distichlis has increased from 4 per cent to 18.2 per cent along transect A and 4 per cent to 11.2 per cent along transect B.

As a result of the restoration work, which increased the elevation in some areas of the Marsh, I would assume that the per cent of the upland plants has also increased. Because Craig did not include his data on the upland plants, this cannot be considered a fact but only an assumption.

Conclusion

I believe the success of Hoffman Marsh restoration project can be evaluated at two levels, or more accurately, at two time scales. The initial results of the mitigation project were anything but positive. The physical constraints of the poor quality sewer pipe, which runs through the dike, directly impeded the completion of the project. The effect the heavy equipment had upon the Marsh was devastating. Large areas of the study site were left barren in worse condition than they were prior to the restoration. This is the time span that future mitigation should learn from. Possibly a little better planning would have resulted in the discovery of the pipe's deteriorated condition. Using lighter equipment, or finding ways to minimize its impacts, could have greatly reduced the scars left behind. These flaws need to be recognized so that they are not repeated.

The other success level of the mitigation project is the long term effect. This is a much more pleasing result. The study site's water quality has increased and the circulation is also much better (Austin, this report). Water is reaching all corners of the Marsh, which has resulted in the recolonization of the vegetation. The vegetation cover is now complete. Bird use in the study site has also risen (Lockwood, this report). These are all positive results, but by no means should they be final results. The study site is still not as healthy as the main marsh and will not be until the culvert construction is complete. Until that time the mitigation is only a partial success.

References

Craig, D., 1985. Vegetation of the Hoffman marsh before the restoration project of 1984. In *Open Space and Development in the Bay Area*; Sloan, D., ed., U.C. Berkeley Environmental Science Senior Seminar report, Berkeley, CA, pp. 15-22.

Faber, P.M., 1982. *Common Wetland Plants of Coastal California; Mill Valley*, CA, Pickleweed Press, 111 pp.

Hay, E., 1985. An ornithological study of the Hoffman Marsh. In *Open Space and Development in the Bay Area*; Sloan, D., ed., U.C. Berkeley Environmental Science Senior Seminar report, Berkeley, CA, pp. 25-32.

Josselyn, M., ed., 1982. *Wetlands Restoration and Enhancement in California*; La Jolla, CA, California Sea Grant College Program, 110 pp.

_______, 1983. *The Ecology of San Francisco Bay Tidal Marshes: A Community Profile*; Washington D.C., U.S. Fish and Wildlife Service, 102 pp.

Merrill, R., and Siegel, S., 1986. Investigation of a Salt Marsh Tidal Prism. Unpublished report for Landscape Architecture 222, U. C. Berkeley, Luna Leopold, Professor, pp. 12-16.

Murry, M.A., and A.J. Horne, 1979. *Studies on Hoffman Salt Marsh; Richmond, California- I nitial Studies on the Inner Marsh and its Acid Pollution*; U.C. Berkeley, Sanitary Engineering Research Laboratory, 44 pp.

Siegel, S., 1985. The rising of the tide- A study of marsh restoration. In *Open Space and Development in the Bay Area*; Sloan, D., ed., U.C. Berkeley Environmental Science Senior Seminar report, Berkeley, CA, pp. 1-13.

URS Research Co., 1973. Marine Environmental Impact Analysis, Widening Highway 17 and 80 Along Shoreline of Richmond, California. San Francisco, California, 150pp.