Editor's note 2025: This report is part of a compilation of reports by students in University of California Berkeley Environmental Sciences 196, senior research seminar, taught by Doris Sloan and Tod Fletcher. As of 2025, an introduction to the Aquatic Park reports is online here: https://nature.berkeley.edu/classes/es196/projects/1989final/1989_Aquatic_Reports_Introduction.pdf
This report is online here: https://nature.berkeley.edu/classes/es196/projects/1989final/index.html

A Survey of Aquatic Vegetation at Aquatic Park

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Introduction

The interactions between both the living and non-living components at Aquatic Park in Berkeley, California, can be defined in a single park ecosystem. Vegetation, water, soil, light, fauna and the effects of humans are all intrinsic components of this ecosystem. Fluctuations in the quantity or quality of one or several of these factors can be indicators of change in the health or stability of the ecosystem. Data on the present state of these factors at Aquatic Park and any changes over time can serve as a guide for city planners in making and implementing decisions regarding park development.

The purpose of this project is to study the aquatic vegetation of the park ecosystem. Both the distribution and diversity of aquatic angiosperms will be mapped and the presence of macroalgae will be monitored. No previous surveys of aquatic vegetation at Aquatic Park have been made. This survey will provide additional information to city planners working on a new Master Plan for Aquatic Park and establish a data base so that vegetational changes over time can be evaluated should future surveys be taken. A special emphasis is placed on the success of native versus non-native populations of terrestrial angiosperms.

Past and Related Studies

Native California marsh vegetation has been identified and described by Macdonald (1977). Wagner (1983) has identified and described native and non-native pioneer plant species which are commonly found in the Bay Area. Silva (1979) has compiled a comprehensive list of benthic algal flora of central San Francisco Bay. Josselyn (1984) has discussed the relationships between certain algal species and specific ecological stresses, such as change in pH, nutrient level, temperature and/or pollution level. In *A Bay Shoreline Landscape Guide* (BCDC, 1984) the San Francisco Bay Conservation and Development Commission explores the advantages of using native Bay Area species versus exotic species.

Aquatic Park has been studied by previous Environmental Science Senior Seminars. Ferlin (1983) has described the history and development of Aquatic Park from its establishment in the 1930's to the present. Altamirano (1983) and Betts (1983) studied aspects of water quality at the park.

A study similar to the present study was conducted by Craig (1985), who surveyed aquatic vegetation at Hoffman Marsh. He researched the percent frequency and percent coverage of three marshland species: *Distichlis spicata* (saltgrass), *Grindelia humilis* (marsh gumplant), and *Salicornia virginica* (common pickleweed).

Background

Aquatic Park is located at the west end of Berkeley. It lies just east of the Eastshore Freeway, between Ashby and University Avenues (Figure 1).

Both the main lake and the model boat pond (Figure 1) at Aquatic Park were studied in this survey. These water bodies cover 67 acres and range from 5 to 7 feet in depth (Montgomery, 1988). The water in both bodies is open to the bay via five tide gates. It mixes with the Bay water and is subject to the tidal fluctuations of the Bay. The water also receives runoff water from the city via storm drains to the west. (For a further discussion of water at Aquatic Park, see Razani, this publication.)

The edges of both the main lagoon and the model boat pond are varied (Figure 1). The south end of the main lagoon is bordered by a sandy shore. The western edge is comprised of either retaining wall or stones or cement blocks. The retaining walls, which are impermeable to water, create a distinct barrier between water and land. The eastern border is bounded at intervals by stone blocks and large cement blocks (approximately 20 cm^3) situated randomly at the water's edge. At some points the stone block border is 2 to 3 meters wide. A series of storm drains and stream inlets flow into the main lagoon at the eastern edge. There is one impermeable retaining wall towards the north end. The northern and eastern edges of the model boat pond are bordered by small stones (10 - 15 cm^3). Both the southern and eastern edges are bounded by a retaining wall. Park developers landscaped Aquatic Park utilizing aquatic and terrestrial plant species that exhibit a natural tolerance to high salinity levels (Ferlin, 1983).

Ecological stresses that have occurred in the past at Aquatic Park include clogged tide gates, dumping by nearby industries, pollutants brought by the storm drains (Ferlin, 1983) and heavy weed growth in the main lagoon during the 1960's (Montgomery, 1988). Profuse duckweed growth in the shallow lagoon consumed a large percentage of the dissolved oxygen, caused fish to die, and created a foul odor. The city purchased a harvester in 1969 to eliminate such growth. The harvester became defunct in 1985 and was never replaced. No controls are currently being applied to impede algal growth.

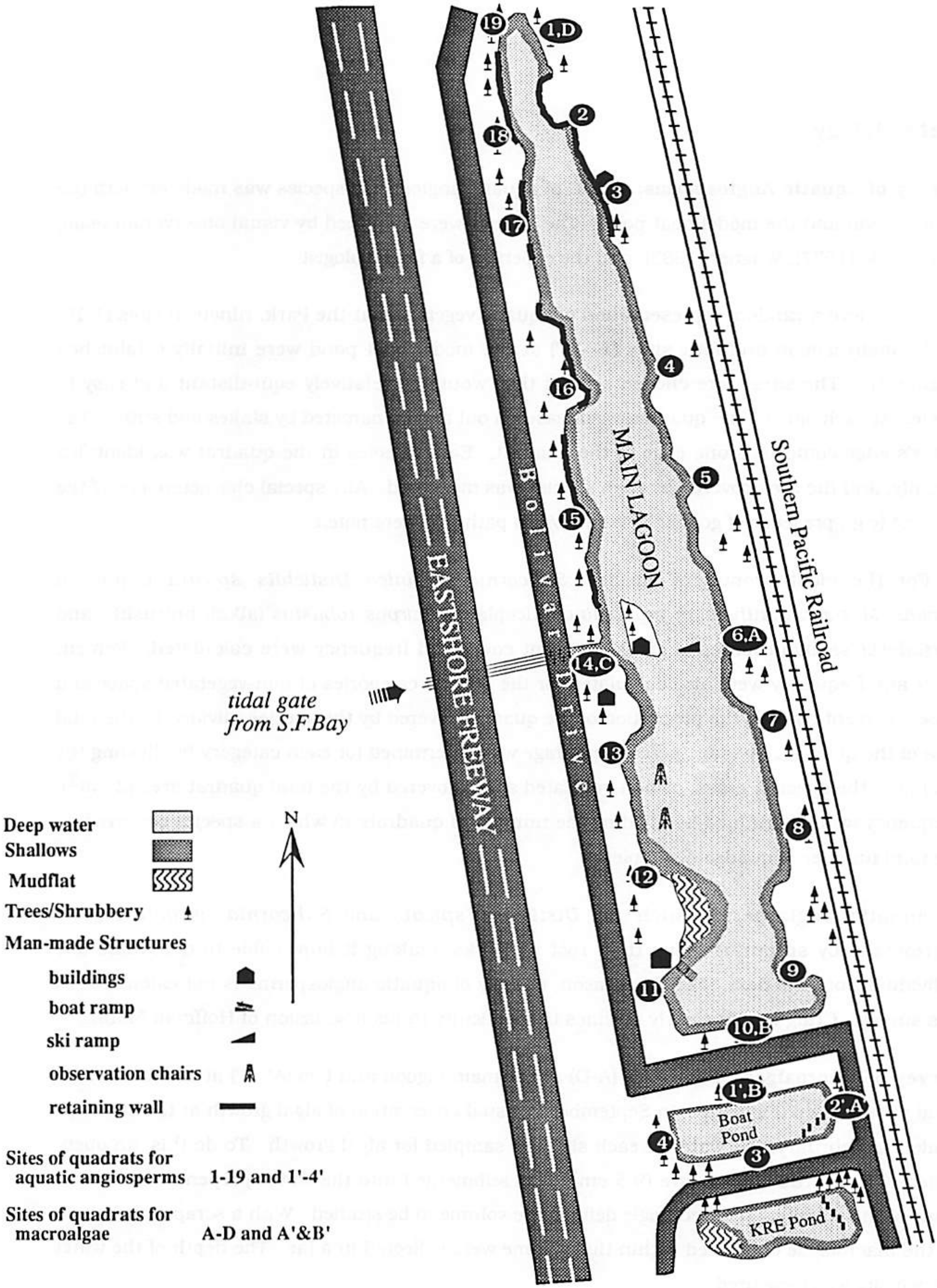

Figure 1. Aquatic Park
Adapted from Ferlin, 1983, not drawn to scale

Methodology

Survey of Aquatic Angiosperms: A list of aquatic angiosperm species was made for both the main lagoon and the model boat pond. The species were identified by visual observation using Macdonald (1977), Wagner (1983), and the expertise of a field biologist.

To achieve a random representation of aquatic vegetation at the Park, nineteen sites (1-19) at the main lagoon and four sites (1' - 4') at the model boat pond were initially established (Figure 1) . The sites were chosen so that they would be relatively equi-distant and easy to locate. At each site a 1 m^2 quadrat was measured out and demarcated by stakes and string. The water's edge comprised one edge of the quadrat. Each species in the quadrat was identified visually, and the area covered by each species was measured. Any special characteristics of the quadrat (e.g., presence of gopher holes and/or a pathway) were noted.

For the most prominent species, *Salicornia virginica*, *Distichlis spicata*, *Grindelia humilis*, *Mesembryanthemum crystallinum* (iceplant), *Scirpus robustus* (alkali bulrush), and *Cortaderia selloana* (pampas grass), percent cover and frequency were calculated. Percent cover and frequency were also calculated for the general categories of non-vegetated space and grass. Percent cover is the proportion of the quadrat covered by the species, divided by the total area of the quadrat. Average percent coverage was determined for each category by dividing the total area the species, grass, or non-vegetated space covered by the total quadrat area (23 m^2). Frequency was determined by dividing the number of quadrats in which a species occurred by the total number of quadrats sampled.

Aquatic angiosperms such as *Distichlis spicata* and *Salicornia virginica* grow horizontally by sprouting along their root networks, making it impossible to determine one individual from the next. For this reason, density of aquatic angiosperms is not calculated in this survey. Craig (1985) clearly outlines this difficulty in his discussion of Hoffman Marsh.

Survey of Macroalgae: Four sites (A-D) at the main lagoon and two (A', B') at the model boat pond were chosen (Figure 1). In September, a visual observation of algal growth at the sites was made. In February, the water at each site was sampled for algal growth. To do this, an open-ended, waxy-cardboard square (9.5 cm^2) was submerged into the water perpendicular to the plane of the surface. This rectangle defined the volume to be studied. With a scraper and a net, all the macroalgae contained within this volume were collected in a jar. The depth of the water at each site was measured.

The algal samples were later analyzed to identify the species present. Each sample was then shaken vigorously and strained through a sieve to remove diatoms, oven dried, and weighed. The density of algae in each volume was calculated by dividing the dry biomass weight by the volume.

Results

Aquatic Angiosperms: Table 1 shows the six aquatic angiosperm species that occurred regularly in the 23 quadrats sampled. *Salicornia, Distichlis, Grindelia,* and *Scirpus* are all native Bay Area species. *Mesembryanthemum* and *Cortaderia* are both species exotic to the Bay Area. The quadrats also contained exotic grass species and a considerable amount of non-vegetated space. Pathways, gopher holes, and shaded, empty patches comprised the majority of the non-vegetated space.

Quadrat	*S. virginica*	*D. spicata*	*G. humilis*	*S. robustus*	**M. crystallinum*	**C. selloana*	*Grass species	Non-vegetated space	Partial/ Full shade
Main lagoon									
1	18	-	-	-	83	-	-	-	N
2	17	-	-	-	-	-	83	-	Y
3	-	-	-	30	-	70	-	-	N
4	67	-	-	-	-	-	34	-	Y
5	-	-	100	-	-	-	-	-	N
6	4	-	-	-	29	-	58	9	Y
7	-	-	3	45	-	-	16	36	N
8	2	-	1	28	-	-	69	-	N
9	-	87	-	-	-	-	-	13	N
10	10	90	-	-	-	-	-	-	N
11	47	-	-	-	-	-	53	-	Y
12	63	-	-	-	-	-	33	4	N
13	11	-	67	-	-	-	13	9	Y
14	-	-	-	-	-	-	-	100	N
15	-	-	-	-	-	-	20	80	Y
16	-	79	-	-	-	-	21	-	N
17	29	27	3	-	-	-	-	41	Y
18	-	-	-	-	-	-	-	100	N
19	-	-	-	-	-	-	100	-	Y
Model boat pond									
1'	64	-	-	-	-	-	15	22	N
2'	6	-	-	-	81	-	13	-	Y
3'	72	-	-	-	-	-	12	16	N
4'	-	58	-	-	-	-	12	31	Y
Average percent coverage	18	15	8	4	8	4	23	20	
Percent frequency	57	22	22	13	13	4	65	52	

* Species exotic to the Bay Area

Table 1. Percent Coverage and Frequency of Vegetation in all Quadrats.

Salicornia is the most widespread of the native aquatic angiosperms in Aquatic Park (Table 1). It occurs in 13 of the 23 quadrats (57% frequency). *Distichlis* and *Grindelia* were the next most prevalent species. Each was identified in five quadrats (22% frequency). The other species occur in fewer than four quadrats. *Cortaderia* occurs in only one quadrat but covered the majority of that quadrat (70% coverage).

Quadrats 15, 16, 18, and 19, located on the western edge of the main lagoon (Figure 1), all are bordered by a retaining wall at the water's edge. None of these quadrats contain *Salicornia* or *Grindelia*. *Distichlis* was found in only one of these quadrats (Table 2). Non-vegetated space or grass composes most of the cover in the other three quadrats. In one quadrat at the model boat pond, a retaining wall is present. In that quadrat *Salicornia* flourishes with 72% coverage (Table 2).

Quadrat	*S. virginica*	*D. spicata*	*G. humilis*	*S. robustus*	**M. crystallinum*	**C. selloana*	*Grass species	Non-vegetated space
Main lagoon								
15	-	-	-	-	-	-	20	80
16	-	79	-	-	-	-	21	-
18	-	-	-	-	-	-	-	100
19	-	-	-	-	-	-	100	-
Model boat pond								
3'	72	-	-	-	-	-	12	16
Average percent coverage	14	16	0	0	0	0	31	39
Percent frequency	20	20	0	0	0	0	80	60

* Species exotic to the Bay Area

Table 2. Percent Coverage in Quadrats which have a Retaining Wall at Water's Edge.

In all quadrats where *Mesembryanthemum* occurs, *Salicornia* is also present, but *Distichlis* and *Grindelia* are not found. *Mesembryanthemum* dominates the overall coverage in the quadrats in which it grew (Table 3).

The percent coverage and percent frequency of the quadrats in which *Salicornia* occurs were calculated separately (Table 4). Non-vegetated space occurs in 46% of the quadrats containing *Salicornia*. Every quadrat containing *Salicornia* also contained an exotic species. *Salicornia* does not appear to be sensitive to shady conditions (Table 4).

Quadrat	*S. virginica*	*D. spicata*	*G. humilis*	*S. robustus*	•*M. crystallinum*	•*C. selloana*	•Grass species	Non-vegetated space
Main lagoon								
1	18	-	-	-	83	-	58	-
6	4	-	-	-	29	-		9
Model boat pond								
2'	6	-	-	-	81	-	12	-
Average percent coverage	9	0	0	0	64	0	24	3
Percent frequency	100	0	0	0	100	0	67	33

• Species exotic to the Bay Area

Table 3. Percent Coverage in Quadrats Containing *M. crystallinum*.

Quadrat	*S. virginica*	*D. spicata*	*G. humilis*	*S. robustus*	•*M. crystallinum*	•*C. selloana*	•Grass species	Non-vegetated space	Partial/ Full shade
Main lagoon									
1	18	-	-	-	83	-	-	-	N
2	17	-	-	-	-	-	83	-	Y
4	67	-	-	-	-	-	34	-	Y
6	4	-	-	-	29	-	58	9	Y
9	2	-	-	28	-	-	69	-	N
10	10	90	-	-	-	-	-	-	N
11	47	-	-	-	-	-	53	-	Y
12	63	-	-	-	-	-	33	4	N
13	11	-	67	-	-	-	13	9	Y
17	29	27	3	-	-	-	-	41	Y
Model boat pond									
1'	64	-	-	-	-	-	15	22	N
2'	6	-	-	-	81	-	13	-	Y
3'	72	-	-	-	-	-	12	16	N
Average percent coverage	32	9	5	2	15	0	30	8	
Percent frequency	100	15	23	7	23	0	77	46	

• Species exotic to the Bay Area

Table 4. Percent Coverage and Frequency in Quadrats Containing *S. Virginica*.

Other typical Bay area angiosperms such as *Baccharis polularis* (coyote brush), *Stellaria media* (chickweed), and *Capsella bursa-pastoris* (shepherd's purse) were also identified along the waterways at Aquatic Park (Table 5).

Scientific name	Common name
Scirpus acutus	common tule
Atriplex patula var. *hastata*	fat hen/salt bush
Baccharis polularis	coyote brush
Stellaria media	chickweed
Capsella bursa-pastoris	shepherd's purse
Medicago polymorpha	bur clover
Brassica campestris	field mustard/yellow mustard
Rumex crispus	curly dock/yellow dock
Rumex acetosella	sheep sorrel
Plantago major	broad-leaved plantain
Plantago lanceolata	narrow-leaved plantain

Table 5. Other angiosperms present at Aquatic Park.

Macroalgae: In September 1988 it was apparent that the model boat pond was overgrown with macroalgae. No quantitative or qualitative investigations were made at that time. In February, 1988, all macroalgae appeared to have disappeared. No macroalgae were found to exist in either the main lagoon or model boat pond in samples taken at that time.

Discussion

Aquatic Angiosperms: The aquatic angiosperms at Aquatic Park occurring with the greatest frequency (*Salicornia*, *Distichlis*, and *Grindelia*) are typical of San Francisco Bay salt marshes (Macdonald, 1977). *Salicornia* averages 32% coverage in the quadrats in which it exists. This suggests that it is subject to competition by other species and is vulnerable to being outcompeted by grasses and pioneer vegetation (atypical salt marsh vegetation). The absence of *Spartina foliosa* (cordgrass) is atypical of Bay salt marshes though. *Scirpus acutus* and *S. robustus* are typical of Bay brackish marshes.

The absence of *Spartina* and the presence of *Scirpus* indicate that Aquatic Park as a floristic province takes an intermediate form between salt and brackish marsh. Tidal flooding through the tide gates is not as pronounced as in marshes open to the Bay. The materials used to border the water's edges can also impede tidal action, an important factor in the success of typical salt marsh vegetation. The retaining walls at the main lagoon prevent full tidal flooding of the shoreline, as evidenced by the lack of halophilic angiosperms such as

Salicornia and *Distichlis*. Steeply sloped banks lower salt concentrations in the soil considerably (Macdonald, 1977). The retaining wall at the model boat pond does not appear to impede water seepage into the soil, as *Salicornia* is able to flourish outside of it.

Areas disturbed in other ways, such as by gopher holes or pathways, provide the opportunity for both native and exotic pioneer species to set root and compete with marsh vegetation (Macdonald, 1977). Exotic species such as *Mesembryanthemum* and *Cortaderia* do not occur with great frequency, but in the quadrats where they do exist, they dominate the coverage and compete with native species. These exotic species have replaced the indigenous ones and possibly are out-competing them.

Many of the other angiosperms that were identified along the waterways at Aquatic Park, such as *Genista* (broom) and *Plantago* (plantain), are species exotic to the Bay Area (Table 5). With the exception of *S. acutus* (common tule), all are "pioneer species", taking root easily in disturbed areas (Wagner, 1983).

The aquatic angiosperms at Aquatic Park are representative of a salt/brackish marsh floristic province. Several factors though, such as competition with exotic plant species, indicate that salt/brackish marsh vegetation is not entirely established or stable.

Macroalgae: Further sampling and testing needs to be conducted to determine the growth cycles of the macroalgae at Aquatic Park.

Conclusion

Planning decisions regarding the vegetation at Aquatic Park are dependent on many seemingly unrelated goals. Aquatic Park was created and is maintained for the purpose of providing a recreation area for the citizens of Berkeley (Ferlin, 1983). To this end it may be practical to remove the marsh vegetation and construct more retaining walls to prevent shore erosion and provide more grassy areas.

Although recreational areas (i.e. frisbee golf courses, par courses and grassy areas) are needed by the Berkeley community (see Miller, this publication), San Francisco Bay is unique for its marshland vegetation. Aquatic Park has the potential to provide accessible opportunities for the Berkeley community to view marshland beauty and learn about marshland ecosystems. There are also aesthetic and practical aspects of maintaining a native and consistent community of vegetation which should not be overlooked. BCDC states:

Native marsh plant landscaping provides a visual compliment to the Bay along the shoreline. Aside from this aesthetic benefit, marsh vegetation planting has considerable practical value. Lower maintenance costs and added soil stabilization are bonuses obtained by using plants adapted to shoreline conditions (BCDC, 1984).

City planning decisions will affect whether Aquatic Park will in future years continue to mimic the Bay shoreline. These decisions will extend far beyond which plants will continue to thrive. Birds, rodents, and other fauna will also be greatly affected. It is my opinion that Aquatic Park's emphasis should be shifted away from purely recreational purposes towards marshland preservation and education. As an adjunct of the Bay, Aquatic Park provides opportunities for such a theme that are completely unfeasible at other park sites. The benefits of fostering native marshland are numerous: community education of its local marshland habitat, preservation of native marshland populations, and the stability provided by native vegetation thriving in equilibrium.

In order to provide for the continued success of a salt/brackish marsh floristic province, aggressive steps need to be taken to combat intrusions by exotic species such as *Mesembryanthemum* and *Cortaderia*. Removal of these species is essential to the success of native plant populations such as *Salicornia*. Physical barriers, such as steep slopes, retaining walls, and large cement blocks, along the water's edge need to be removed to allow for a better saturated, more gradually sloped, broader (2-3m) area on which terrestrial angiosperms can flourish. The five tide gates need to be maintained to ensure thorough mixing of park waters with Bay waters and proper tidal fluctuations.

I strongly recommend to city planners that they attempt to preserve a natural Bay habitat at Aquatic Park. Native marshland vegetation can provide an aesthetically pleasing and educational environment for the human visitors of Aquatic Park as well as maintaining foliage and fodder for native Bay Area shoreline animal species.

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