West Stege Marsh and Ecotone Revegetation Plan (2003-5)

U.C. Berkeley Field Station

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Prepared for Blasland, Bouck & Lee, Inc.

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Appendix, Figures, and Tables

INTRODUCTION

In the past 200 years California has lost approximately 95 percent of its riparian vegetation, resulting in fragmented and often degraded habitat. This loss is perhaps magnified in the San Francisco Bay Area, which was recently identified as one of the six biodiversity hotspots in the world (Nature Conservancy, 2000). Studies throughout the Bay Area indicate that ecological function and vegetation richness and abundance have declined significantly in wetland systems as urban development has increased and invasive non-native species have become established. As a result, essential habitat for neotropical migrants, water fowl, fish, invertebrates and other wildlife has been greatly reduced, leading to a decline in wildlife richness and increasing numbers of locally rare wildlife populations.

The University of California at Berkeley (UCB) Richmond Field Station (RFS) supports grassland and wetland habitat of high ecological value. The RFS occupies approximately 72 acres of marsh and mudflat, and 23 acres of upland terrace prairie habitats. Included within these areas are a diversity of habitat types that support a number of native vegetation communities including salt and brackish marsh, freshwater meadow and seep associations, and coastal scrub. Many of these habitats have been disturbed through the introduction of fill materials, the invasion of non-native plant species, increased development, and the impacts of past industrial operations from on (and off) site sources. Today, these habitats support more than 62 native plant species, including some that are considered locally rare. Initial genetic testing of the cordgrass located within the slough and marsh has determined that the marsh habitat within the RFS supports only *Spartina foliosa* (Pacific cordgrass) – an increasingly rare phenomenon. In addition West Stege marsh supports a diversity of wildlife species including the federally endangered *Rallus longirostris obsoletus* (California Clapper Rail) – several nesting pairs were observed during recent surveys.

Current marsh remediation efforts provide a unique opportunity to enhance West Stege Marsh, by increasing native vegetation richness. The goal of the revegetation effort (and this plan) is to promote species diversity and advance the establishment of a viable seed bank while maintaining an opportunity for natural vegetative recruitment within the regraded marsh habitat.

REVEGETATION PLANT PALETTE

Species Selection

In an attempt to recreate the historic species palette, local wetland restoration projects, early botanical records, and some herbarium records were consulted. Because these sources were incomplete, plant species occurring in contemporary adjacent and analogous wetland systems were also considered. Dominant aggressively growing species, including annual pickleweed (*Salicornia europea,* Chenopodiaceae) and some prolific native species, like dodder (*Cuscata salina var. major*, Cuscutaceae), salt grass (*Distichlis spicata,* Poaceae) and spearscale (*Atriplex triangularis*, Chenopodiaceae) were eliminated from the revegetation plan in anticipation of natural colonization. Perennial pickleweed (*Salicornia virginica*, Chenopodiaceae) and Pacific cordgrass (*Spartina foliosa,* Poaceae), which have successfully established in Bay Area wetlands without assistance, were eliminated in anticipation of natural colonization. By eliminating or limiting the presence of these species in the revegetation plan, and implementing the approved vegetation monitoring program to assess for their establishment, we hope to provide a greater opportunity for the establishment and

expansion of the less common species selected for revegetation. This will promote the goal of establishing greater biological diversity.

If vegetation monitoring data indicates that the desired species are not colonizing at rates equal to, or above the established performance measures, the restoration site will be adaptively managed to meet the performance criteria. This could include revegetation activities in the low marsh habitat if deemed appropriate by Blasland, Bouck & Lee, Inc..

Based on the above, revegetation actions in the low and mid marsh habitat shall be limited to only sparse plantings of locally rare plant species to increase vegetation richness. The ecotone (high marsh habitat) will be planted with densely with species as described in Tables 1-3.

The following 11 species are proposed for the marsh revegetation palette (revegetation to occur 2004-5[1]):

Table 1

Plant Family	Latin name	Common Name
Asteraceae	Grindelia stricta var. augustifolia	Marsh gum plant
Asteraceae	Jaumea carnosa	Salty susan
Asteraceae	Lasthenia glabrata	Marsh goldfields
Boraginaceae	Heliotropium curasssavicum	Marsh heliotrope
Carophyllaceae	Spergularia macrotheca var. macrotheca	Perennial sand-spurrey
Carophyllaceae	Spergularia marina	Annual sand-spurrey
Cyperaceae	Scirpus maritimus	Bulrush
Frankeniaceae	Frankenia salina	Alkali-heath
Juncaginaceae	Triglochin maritima	Giant arrow grass
Plumbaginaceae	Limonium californicum	Western marsh rosemary
Poaecae	Spartina foliosa	Pacific cordgrass
Scrophulariaceae	Castilleja ambigua ssp. ambigua	Johnny-nip

Propagule Collection Site Selection

Because the West Stege Marsh restoration site does not support all of the species outlined in Table 1, collection sites were chosen outside of the restoration footprint. Ideally, plant materials collected would share genetic links to historic plant populations or originate from sites with conditions similar to the West Stege marsh conditions. To achieve these goals, the following factors were considered when selecting propagule collection sites:

1) ecological habitat similarity (soils, wave exposure, disturbance patterns, nutrient inputs, etc.);
2) natural species dispersal vectors;
3) proximity to the introduction site. After evaluation, 5 collection sites have been selected within a 10-mile radius of the West Stege Marsh restoration project.

[1] A limited umber (less than 600 spartina foliosa propagules will be outplanted between December 2003 – February 2004 in low marsh habitat once the berm is breached. Revegetation of the remaining low marsh habitat will be dependent on natural recruitment.

NURSERY PROPAGATION AND OUTPLANTING GOALS

Determination of Goals

The outplanting goals were determined by the following considerations:

1) the desired density of plants – Our goal is to plant at a density that would both successfully promote the establishment of a diverse seed bank (without inhibiting native vegetation recruitment), and limit available habitat for early colonizing invasive non-native plant species. We anticipate that this can be reached by planting on 4-ft centers (an average of 1 plant every 4 sq. ft).
2) the size of the planting area - For the marsh revegetation component of the environmental remediation effort, all plantings will occur between 2.5 and 6 ft NGVD. This elevation range falls within the optimal growth habitat. The project designers, Blasland, Bouck & Lee, Inc. estimated this total planting area to be approximately 77,500 sq. ft.

Propagation goals

Propagation goals for individual species were determined by the following information:

1) the estimated frequency of species occurrence – Propagation ratios were developed to mimic natural species assemblages to the greatest degree feasible. Species assemblage data was based on field observations, reference books, and past project and expert recommendations.
2) dominant method of establishment (seed, clonal growth, or both) - Many salt marsh species expand primarily through clonal growth. In many cases, the seeds dispersed by clonal species have very low germination rates. In anticipation of low seed recruitment, clonal species, like salt grass (*Distichlis spicata*, Poaceae), will be propagated/planted in larger quantities in order to promote their establishment throughout the site.
3) rarity of species - Less common species will be propagated/planted at slightly inflated ratios in anticipation of field mortality and future competition.

The propagation goals are as follows:

Table 2:

Plant Family	Latin name	Common Name	Propagation Goal
Asteraceae	Grindelia stricta var. augustifolia	Marsh gum plant	154
Asteraceae	Jaumea carnosa	Salty susan	184
Asteraceae	Lasthenia glabrata	Marsh goldfields	65
Boraginaceae	Heliotropium curasssavicum	Marsh heliotrope	130
Carophyllaceae	Spergularia macrotheca var. macrotheca	Perennial sand-spurrey	130
Carophyllaceae	Spergularia marina	Annual sand-spurrey	65
Cyperaceae	Scirpus maritimus	Bulrush	61
Frankeniaceae	Frankenia salina	Alkali-heath	184
Juncaginaceae	Triglochin maritima	Giant arrow grass	123
Plumbaginaceae	Limonium californicum	Western marsh rosemary	130
Poaecae	Spartina foliosa	Pacific cordgrass	600
Scrophulariaceae	Castilleja ambigua ssp. ambigua	Johnny-nip	65

PROPAGULE COLLECTION

Guidelines

Propagule collection will be performed by AOI staff and contractors with support from UC Berkeley and community volunteers. Marsh species propagule collection began during summer 2003, and will continue through fall 2004.

Seeds will be collected by hand in paper envelopes or grocery bags. To protect propagule resources, no more than 10% of the seeds from any 1 population or individual plant will be collected throughout the season[2]. Seeds will be collected from each species throughout its ripening season in order to include a diverse range of flowering times in the collection pool. Divisions will be extracted using flat-bladed shovels. Records pertaining to propagule collection will be recorded, and included in a final revegetation report.

The West Stege marsh supports *Spartina foliosa*. Given the potential for introducing Spartina alterniflora, propagules will only be collected from the West Stege Marsh. Collection will be completed by 40-hour OSHA trained UC Berkeley and BBL staff as the propagules are located in areas with potential contaminants. Propagules will be cleaned and divided on site by AOI staff . All cleaning will be completed using hand tools.

Propagule collection permits and records

Permits have either been acquired, or requested from the collection sites to secure propagules for the West Stege Marsh restoration efforts. A list of collection sites and propagules collected will be included in the final revegetation report. Propagules for a number of locally rare species will be collected over several years as they have limited population sizes and distribution. These species will be inplanted during the first three years of the project.

OUTPLANTING DESIGN

Appendix I includes a map of the final grading plan that was used to develop the outplanting design and propagation goals. The spatial arrangement and densities of plant species is based on field observations, reference books and documents, and recommendations from local wetland experts.

Tidal Zone Specifications

Each salt marsh species concentrates its growth within a specific tidal zone dictated by its salt tolerance, tolerance of tidal inundation, and ability to compete. Each of the marsh species proposed for revegetation will be planted within its optimal tidal zone to mimic this natural vegetative tidal distribution and enhance outplanting survivorship. Table 3 is a listing of the tidal zone specifications for each species:

Table 3

Latin name	Tidal zone
Spartina foliosa	Low marsh
Distichlis spicata	Middle marsh
Frankenia salina	Middle marsh

[2] A higher percentage will be taken if the area is scheduled for remediation or other activities that would result in the disturbance or loss of the population.

Latin name	Tidal zone
Jaumea carnosa	Middle marsh
Triglochin maritima	Middle marsh
Castilleja ambigua ssp. ambigua	Middle to high marsh
Scirpus maritimus	Middle to high marsh
Grindelia stricta var. augustifolia	High marsh
Heliotropium curasssavicum	High marsh
Limonium califronicum	High marsh
Spergularia marina	High marsh
Spergularia macrotheca var. macrotheca	High marsh

Planting Patterns

Propagules will be planted within designated tidal zones using two general design patterns: independent and colonial. These planting patterns are designed to mimic natural growth patterns and habitat specifications for most salt marsh species and will provide greater ease and direction for volunteers during outplanting. **Independent plantings** are defined as groupings of 3 or 5 plants of a single species planted randomly within prescribed tidal zones on 1-3 ft centers. **Colonial plantings** are defined as groupings of 5 to 200 plants of a single species planted at a predetermined location on 1 to 3 ft centers. (*Note*: while the planting densities cited are less than the "4-foot center" cited earlier in this plan, the average overall planting center will be 4-foot intervals.)

Colonial plantings will assigned to species that naturally occur in concentrated homogenous patches, like salty susan (*Jaumea carnosa*, Asteraceae), or require specific microhabitat conditions.

Spartina Planting

Spartina divisions will be placed in the low marsh habitat in groupings of 1-3 rhizomes on 2-foot centers throughout the low marsh habitat (see outplanting section on pages 8-9).

Planting Locations

Colonial species will be evenly distributed throughout the tidal zones specified above or if necessary, will be assigned specific planting locations consistent with both microhabitat (elevation, slope, wind exposure, soil contour, and saltwater exposure) and tidal zone specifications.

Independent species will be randomly distributed within specific elevations throughout the marsh. Tables 5 and 6 summarize the planting specifications for each species.

Table 5: Clonal species

Latin name	Common Name	Planting centers (ft)	# per clump	Est. planting area	Planting elevation (ft)
Jaumea carnosa	Salty susan	3	61	4 x 50	2.5 – 3.5
Heliotropium curasssavicum	Marsh heliotrope	1	43	4 x 40	5
Frankenia salina	Alkali-heath	2	61	4 x 50	3 – 3.5
Triglochin maritima	Giant arrow grass	3	41	4 x 40	3

Table 6: Independent species

Latin name	Common Name	grouping
Grindelia stricta var. augustifolia	Marsh gum plant	Threes
Lasthenia glabrata	Marsh goldfields	Fives
Spergularia macrotheca var. macrotheca	Perennial sand-spurrey	Threes
Scirpus maritimus	Bulrush	
Limonium californicum	Western marsh rosemary	Threes

OUTPLANTING

Outplanting will be phased over three years. Outplanting will begin in November and continue through February each year. Wetland outplanting conditions are ideal at this time of year because winter rainfall has significantly reduced bay salinity levels and flushed high concentrations of salt from the soil. While halophytic vegetation is adapted to living in saltwater conditions, the salt is still toxic to the plant. Planting when salinity levels are reduced provides the nursery plants with an opportunity to gradually acclimatize to the bay's increasing salt conditions. We anticipated that outplanting conditions during 2003 will not ideal because the berm may not be breached. Additionally, marsh slopes may not have had time to stabilize after the fall grading activities, and there may be some soil accretion and erosion within each planting zone as the marsh stabilizes. Plots will be established in the first year to monitor soil accretion and erosion. Monitoring will be conducted by BBL Inc..

Because of the circumstances described above, and the fact that marsh propagule collection tasks were not approved and funded until fall 2003, the outplanting of all species other than the limited *Spartina foliosa*, and the direct seeding of annual species, Johnny-nip (*Castilleja. ambigua ssp. ambigua, Scrophulariaceae)* and sand spurrey (*Spergularia marina*, Carophyllaceae), will be deferred until the 2004 outplanting season when field conditions might be more favorable.

<u>Site preparation</u>

In order to identify planting locations, tidal elevations should be staked every 20 lateral ft at 1-ft increments. To aid volunteers in planting marsh species the tops of the stakes will be spray painted with different colors to indicate specific elevations.

Yellow=2 feet
Blue=3 feet
Purple=4 ft
Red=5 feet

The marsh will be divided in to 3 sectors for revegetation survivorship monitoring purposes. These sector designations will also be utilized for the division of planting areas

during volunteer workdays. The beginning/end of a sector will be defined by a row of pin flags running perpendicular to the elevation gradient of the marsh.

Cordgrass Planting

Spartina foliosa will be planted sparsely to promote vegetative growth within the low marsh habitat. It is anticipated that this species will naturally colonize the site to the vegetation cover specifications required.

Spartina foliosa divisions will be collected by U.C. Berkeley staff and consultants. Plant material will be excavated using the following methods: (1)with shovels and transported in plastic 5-gal buckets to a designated staging area; and (2)with heavy equipment from remediation areas, and then cleaned and transported in plastic 5-gal buckets to a designated staging area . Efforts will be made to plant all divisions as quickly as possible follow the regarding of the site and the breaching of the berm. Plugs will be transplanted at the species' natural elevation on 2-foot centers to enhance survivorship. We anticipate that approximately 20-30% of the plugs may be displaced during the fist season as the marsh grading equilibrates.

Outplanting Other Species

Planting of the nursery-reared plants will begin in November 2004 and continue until December 2005[3]. Planting efforts will be led by AOI staff and volunteer team leaders from the Environmental Sciences and Training Program. On planting days, volunteers will be directed to retrieve a specific number of plants from the nursery and either distribute them evenly within a pin flagged colonial planting area or in groups of 3's or 5's throughout the sector at a specific elevation designated by colored stakes. Hand picks and small bulb planters will be used to dig planting holes. Digging holes in the marsh mud will be time consuming and volunteers will be tasked to walk on wooden planks (or plywood) to prevent sinking into the planting areas. Planting holes were tailored to the pot size of the transplant and will be approximately 3 inches deeper and wider than the pot. When available, kelp salvaged from the adjacent site will be planted at the base of planting holes to act as a natural fertilizer.

[3] 90% of plantings will be completed by January 2005, and inplanting will continue through December 2005 based upon monitoring results and locally rare plant propagules.