I.   Executive Summary of Project Goals and Results

During the 12 months of this contract (April 1, 2009- March 31, 2010), the Save The Bay (STB) Shoreline Habitat Restoration Project has completed enhancement of tidal marsh ecotone habitat adjacent to 300 acres of tidal flats at Eden Landing Ecological Reserve (Eden) in Hayward and 50 acre tidal marsh habitat at Martin Luther King Regional (MLK) Shoreline Park in Oakland. Ecological improvements were made through removal of 6000 pounds of invasive species and revegetation of 2.24 acres (1.4 acres at Eden Landing and 0.84 acres at MLK) of habitat for sensitive species with native plants. Ecological enhancement in habitat included improvements in native coverage consistent with the recovery plan for the salt marsh harvest mouse and the California Clapper rail indicating "upper portions of marshes must be restored to provide refugia for both species"[1] and the *Draft Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California* which indicates ecotone marsh-to-terrestrial ecotones should be expanded or restored.[2]

The Shoreline Habitat Restoration Project has established native tidal marsh habitat through propagating 7112 native plants in our native plant nursery from seeds collected on site and through the outplanting of 7112 native plants and removal of over 6000 pounds of invasive weeds at our two restoration sites. Invasive coverage was reduced by an average of 75% along the 300 meter levee at Eden Landing. Native plant coverage increased by an order of five on this levee. At our MLK restoration project sites, we recorded an average decrease in invasive coverage of 30% and an increase in native plant coverage of an average of 15%. See summary of monitoring data below. Our restoration activities were accomplished through 47 educational programs with the help of over 900 community volunteers.

II.   Description of project components (tasks)

To complete the project, STB provided (1) project management, (2) developed measurements of success, (3) conducted native plant propagation and planting, and invasive plant removal, (4) evaluated plant establishment, and (5) performed strategic planning and stakeholder support.

As part of the project management task, STB prepared quarterly reports, financial statements and oversaw personnel responsible for the Shoreline Restoration project. The quarterly reports discussed project activities conducted during the quarter and progress towards milestones.

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[1] U.S Fish and Wildlife Service. 1984. Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan. Portland Oregon.. pg. 47.
[2] U.S. Fish and Wildlife Service. 2009. Draft recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California. pgs 197 and 213.

To develop measurements of success, a Quality Assurance Project Plan (QAPP) was developed in conjunction with the San Francisco Estuary Institute (see further discussion below).

To complete the native plant propagation and planting, and invasive plant removal task, STB coordinated 47 Community-based Restoration projects in which volunteers helped to manually remove invasive species, collect seeds on-site, propagate seeds in native plant nursery, and outplant seedlings following invasive removal (see further discussion below).

To evaluate plant establishment, STB restoration staff conducted monitoring using protocols from the approved QAPP and assessed data collected under these protocols (see further discussion below).

To perform strategic planning and stakeholder support, STB participated in numerous outreach events including a tour of the Eden landing Ecological Reserve attended by numerous stakeholders from the San Francisco Bay Advisory Board, San Francisco Bay Restoration Authority, the California Coastal Conservancy, and representatives of elected officials. Media outreach included 7 news articles, numerous blog entries, and a short video of our restoration activities produced by Mother Nature Network.

III.   QAPP Development

The QAPP for the STB Shoreline Restoration Project was developed in coordination with the San Francisco Estuary Institute. The draft monitoring protocol that was developed through the QAPP process can be used as a standardized protocol for data collection to track restoration outcomes (Attachments B and C). This protocol is intended to meet the need for standardized data about the responses of the ecotone plant community to onsite vegetation management. This protocol can also be used in broader surveys of the ambient condition of the ecotone. Standardized use of this protocol will allow comparisons between management actions and ambient conditions. For this project, STB monitoring data was used to assess the change in percent cover of native vs invasive species at our restoration sites at MLK and Eden prior to restoration activities and following non-native plant removal and outplanting of over 7000 native plants in the ecotone.

In this protocol, plant community structure is assessed in terms of the vegetative cover (i.e., the percent of a specified area of land surface within the transition zone that is covered by each plant species living in the ecotone), the maximum height of the species, and the percent cover of non-native species. Data on vegetative cover that are collected before and after restoration efforts can be used to assess their progress or performance.

The QAPP for this project presents functions and procedures to meet the objects of the monitoring and analysis of the native plant communities at the STB salt marsh

transition zone restoration sites. This work was performed by STB restoration experts. The monitoring protocol presented here was designed to assess the progress towards, and the success or failure of, STB's salt marsh transition zone habitat restoration projects. A summary of these results are described below. Following the conclusion of this year-long project, the STB Native Plant Monitoring Program will implement long-term vegetation monitoring of restoration sites to evaluate the future success of restoration efforts.

IV. Summary of Expected Outputs and Outcomes and Accomplished Deliverables

The primary outputs expected for this project included the following:
1. Baseline ecological assessment data for restoration sites;
2. 7,000 native plants planted at restoration sites;
3. 750 volunteers trained to assist with restoration;
4. 6,000 lbs of invasive plants removed from restoration sites; and
5. 30 community volunteer restoration events with at least 25 volunteers each provided.

The primary outcomes expected for this project included the following:

1. Reduced risk of infestation of invasive plants at two project locations (MLK Shoreline and Eden Landing);
2. Propagation of 7000 native plants;
3. Removal of 6000 pounds of non-native plants at our two project sites;
4. Outplant 5000 native plants at MLK and 2,000 plants at Eden;
5. Increase area of native plant cover and decrease area of invasive plant cover; and
6. Educate and involve 750 volunteers.

Within the contract period of April 1, 2009- March 31, 2010, STB monitored plants to provide baseline ecological assessment data, propagated and planted 7,122 plants and removed 6000 pounds of invasive plants within 2.24 acres (1.4 acres at Eden Landing and 0.84 acres at MLK) of tidal-upland ecotone with the help of 911 volunteers for a total of 6608 project hour during 47 community-based restoration events.

V. Methodology and Execution

From April 1 2009 to March 31 2010, STB enlisted and mobilized trained volunteers to revegetate 2.24 acres (1.4 acres at Eden Landing and 0.84 acres at MLK) and

enhance over 350 acres of transition zone areas adjacent to high quality tidal salt marsh habitat, increase vegetation structure and provide detrital resources to benefit aquatic and terrestrial species. Restoration activities included:

- Removed debris from the site and reduced infestations of invasive plants such as *Lepidium latifolium* (pepperweed)*, Mesembryanthemum crystallinum* (iceplant)*,* and *Foeniculum vulgare* (fennel) through strategic manual removal of invasive species by utilizing STB's integrated multi-tooled invasive eradication and prevention approach including adaptive weed management through site surveys, minimization of soil disturbance, blacktarping, hand pulling, selective digging, seed head looping and sheet mulching.

- Collected native plant seeds, including *Grindelia stricta* (marsh gumplant), *Distichlis spicata* (salt grass), *Frankenia salina* (alkali heath), *Limonium californica* (marsh rosemary), *Leymus triticoides* (beardless wildrye) and *Jaumea carnosa (*fleshy Jaumea), on site and propagate them in native plant nurseries.

- Monitored and evaluated restoration success using STB and San Francisco Estuary Institute's Transition Zone Monitoring Protocol: *Data Collection Protocol: Plant Community Structure of Intertidal-upland Ecotone* (Attachment B)*.*

- Educated students, corporate and community groups, and residents about wetland restoration through 47 community-based restoration programs and 750 volunteers. Program curriculum consisted of a 2 hour introduction on tidal marsh ecology and restoration techniques, 2-3 hour restoration activity (seed collection, propagation, planting or non-native plant removal), and program debrief.

- Leveraged community support for the Bay-wide wetland restoration through strategic partnerships, and media outreach and volunteerism for our 47 community-based restoration programs (See example media article, Attachment D). Conducted one site partner training on weed removal techniques in February of 2010 and lead a regional workshop on community-based restoration September 24th, 2009.

VI. Summary of Monitoring Data

Invasive Plant coverage was measured prior to restoration activities and following invasive removal and planting activities in March using our approved QAPP methods. The below table summarizes data collected pre and post restoration activities conducted under this project:

STB Project Name	# sites	# of strata	# plots per strata	Total plots	% cover native prior	% cover non-native prior	% cover native after	% cover non-native after
Eden Landing	5	4	6	120	**5.6**	**68.45**	**33.55**	**15.25**

Site	Stratum	% cover native prior*	% cover non-native prior*	% cover native after*	% cover non-native after	Change in native*	Change in non native*
ELC1	IT	5	55	45	25	40	-30
ELC1	Low	14	65	25	10	11	-55
ELC1	Middle	9	53	55	15	46	-38
ELC1	High	2	78	35	15	33	-63
ELC2	IT	15	35	15	10	0	-25
ELC2	Low	3	85	25	15	22	-70
ELC2	Middle	3	74	45	15	42	-59
ELC2	High	5	90	35	10	30	-80
ELC3	IT	8	10	10	10	2	0
ELC3	Low	5	78	45	20	40	-58
ELC3	Middle	2	92	55	15	53	-77
ELC3	High	0	86	47	12	47	-74
ELC4	IT	15	25	18	15	3	-10
ELC4	Low	3	76	45	25	42	-51
ELC4	Middle	2	95	28	20	26	-75
ELC4	High	4	93	50	10	46	-83
ELC5	IT	5	26	10	15	5	-11
ELC5	Low	6	78	25	20	19	-58
ELC5	Middle	3	92	30	15	27	-77
ELC5	High	3	83	28	13	25	-70

STB Project Name	# sites	# of strata	# plots per strata	Total plots	% cover native prior	% cover non-native prior	% cover native after	% cover non-native after
MLK	3	4	6 to 9	91	**26.17**	**6.5**	**31.50**	**4.22**

Site	Stratum	% cover native prior	% cover non-native prior	% cover native after	% cover non-native after	Change in native	Change in non native
MLKWB1	IT	15	2	15	0.5	0	-1.5
MLKWB1	Low	38	4	51	2.6	13	-1.4
MLKWB1	Middle	51	12	60	2.2	9	-9.8
MLKWB1	High	25	3	28	0.42	3	-2.58
MLKWB2	IT	22	7	26	4	4	-3
MLKWB2	Low	28	5	32	0.6	4	-4.4
MLKWB2	Middle	33	6	40	5	7	-1
MLKWB2	High	25	11	32	4	7	-7
MLKWB3	IT	12	5	18	0.3	6	-4.7
MLKWB3	Low	20	6	22	6	2	0
MLKWB3	Middle	15	13	19	15	4	2
MLKWB3	High	30	5	35	10	5	5

* Percent cover measured "prior" to restoration activities conducted under this project and "past" restoration activities

VII.   Evaluation

     a. Outcome accomplishments vs expected results

STB was able to accomplish all identified outputs through the described tasks. The substantial decrease in non-native plant coverage from 68% prior to restoration activities to 15% coverage compared to the less drastic change at MLK of 7% to 4% may be explained by past STB restoration activities at the later site. The ELC project site at Eden was absent of previous revegetation activities and had on average 65% bare ground prior to restoration activities. Monitoring activities indicate that an increase in native plant coverage recorded after immediate revegetation of native plants following removal activities at this site.

On the other hand, the MLK restoration site was immediately adjacent to a 7 year STB restoration project and sporadic invasive removal activities had occurred within this site throughout that time. Native seed recruitment from surrounding restoration activities is also likely.

     b. Lessons learned and project implications

Save The Bay has been successfully removing invasive species and planting native intertidal-upland marsh species for 11 years at our restoration sites at the Martin Luther King Regional Shoreline Park. Long term maintenance at these sites, may contribute to a visibly lower percentage of invasive infestations and higher native plant diversity compared to adjacent sites in which there has been no vegetation effort. We have planted over 25 native plant species in five different sub sites and have monitored and maintained these sites following restoration activities.

On the other hand, the 1.4 acre ecotone project site at Eden is a levee adjacent to a recently restored retired salt pond. Revegetation activities were non-existent at this site prior to April 2009. Soils consisted of a variety of fill material and pre-restoration vegetation was almost 100% non-native. This probably contributed to our high initial success rate in reducing non-native plants. Our plant pallet consisted of only one species at this site for revegetation (marsh gumplant) which had a lower survivorship rate than those planted at MLK sites probably due to the poor substrate. Long term monitoring (> ten years) coordinated with maintenance activities at this site is essential to identifying if long term maintenance is necessary to obtain a sustainable and diverse intertidal-upland ecotone. STB plans to continue maintenance and monitoring of this site over the next 10 years to access the success of restoration activities in creating a diverse habitat for wildlife and enhancement of ecosystem functions for the tidal marsh.

The lessons learned from the project included the following:

- Soil analysis and survivorship monitoring should be incorporated into the monitoring of restoration sites to help identify an appropriate planting palette for the next planting season and for similar levees at other restoration sites around the Bay. Results of periodic soil analyses can also be used to identify the need for soil amendments, mechanical breaking up, or other treatments to improve plant establishment.
- Removal of invasive plants before replanting with native plants can reduce invasive plants and increase native plant diversity the first year after treatment.
- Consistent long term monitoring is needed to assess whether treatments are effective over a longer period.
- Results in change in percent plant coverage are dynamic within sites and planting plans should be adjusted not only based on site location but other physical characteristics of the habitat (i.e. elevation, tidal regime, changes in fill material on levees, and restoration history of adjacent habitat).
- Time of year for monitoring may influence perception of percent cover of native vs non-native plants at site (i.e. non-native grasses dominate in late spring./early summer). We recommend, when possible, adding an additional monitoring window in the fall.

c. Partnerships

Over the past 10 years, Save The Bay has developed and coordinated numerous unique partnerships. Funding through the San Francisco Estuary Partnership helped support the creation of collaborations vital to region-wide sustainability and coordination of tidal marsh restoration in the San Francisco Bay Estuary. Some of the significant partners of STB and the corresponding implications of these partnerships are outlined below:

- San Francisco Estuary Partnership: coordinated effort to restore many habitats Bay-wide and to collectively adapt restoration efforts based on collected data
- San Francisco Estuary Institute (SFEI): Creation of a standardized monitoring protocol to gauge the success of restoration efforts in the intertidal-upland tidal marsh ecotone. SFEI and STB have been working to collaborate the protocol and manage a central database for all restoration projects using this protocol
- Invasive Spartina Project (ISP): STB and the ISP are working together to coordinate revegetation of tidal marsh ecotone immediately following spartina spraying to ensure adequate habitat for sensitive species such as the California clapper rail
- East Bay Regional Parks District (EBRPD): A long term partner of STB, EBRPD and STB hold quarterly trainings and workshops for

staff and other practitioners to ensure a coordinated restoration effort within the Park District
- California Department of Fish and Game: STB works closely with Fish and Game to target appropriate restoration sites to supplement larger restoration efforts such as levee breaching and trail building
- United States Fish and Wildlife Service

d. Future work

To prevent future invasive species infestations, STB will monitor restoration sites yearly and following to target non-native removal and to continue to increase diversity by planting a variety of appropriate species for each site. Maintenance will continue for no less then 10 years at each site and future restoration efforts are planned for adjacent ecotone habitat (for Eden, complete restoration of 1000 meter levee and finish ecotone restoration in MLK New Marsh up to seasonal ponds). The intent of this maintenance is to decrease risk of infestation by reducing non-native seed sources from both within the site and surrounding habitat. Increase in native coverage through revegetation over the next ten years will also help out-compete non-native reestablishment.

Continual monitoring of restoration sites and future maintenance activities with the *Data Collection Protocol: Plant Community Structure of Intertidal-upland Ecotone* will be used to guide regional ecotone restoration. This information will be transferred to other restoration practitioners through the partnerships strengthened during this project and the implementation of regional practitioner workshops and trainings.

VIII. Conclusions

Loss of vital tidal marsh ecotone habitat due to fill or alteration has resulted in a dramatic decline in tidal marsh depended fish and wildlife. It has also caused an increase in risk of flooding and a decrease in water quality of the Bay. Over the past decade, there have been numerous large restoration projects (e.g., The South Bay Salt Pond Restoration Project) aimed at returning tidal influence to salt marsh habitat. Restoration of intertidal-upland ecotone adjacent to these restored marshes is imperative to sustaining tidal marsh ecosystem functions.[3]

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[3] U.S. Fish and Wildlife Service. 2009. Draft recovery Plan for Tidal Marsh Ecosystems of Northern and Central California. Sacramento, California; Goals Project. 1999. Baylands Ecosystem Habitat Goals. A report of habitat recommendations prepared by the San Francisco Bay Area Wetlands Ecosystems Goals Project. U.S. Environmental Protection Agency, San Francisco and the San Francisco bay regional Water Quality Control Board, Oakland, California.

The lessons from this project as well as the collaborative partnerships strengthened over the past year will be transferred to other restoration practitioners to effectively implement adaptive restoration. STB and partners will organize trainings and workshops to relate these and other lessons to region wide practitioners.

IX.   Attachments

Attachment A

Photos of restoration site and restoration activities

Save The Bay volunteers Remove Iceplant at Martin Luther King Regional Shoreline Park: July, 2009.

Youth volunteer planting native plants at Martin Luther King Regional Shoreline, February 2010.

Volunteers removing non-native plants, Martin Luther King Regional Shoreline, April 2010

Martin Luther King regional Shoreline site following 2009-10 planting season.

Volunteers plant native gumplant at Eden Landing Ecological Reserve, March 2010.

Eden Landing ecological Reserve following STB 2009-10 planting activities.

STB volunteers removing invasive plants, Eden Landing Restoration Site, March 2010.

Attachment B

San Francisco Estuary
Wetlands Regional Monitoring Program

Data Collection Protocol
Plant Community Structure of Intertidal--Upland Ecotone
Draft

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Introduction

This protocol is designed for assessing the ambient condition of vegetation and the effectiveness of vegetation management in the ecotone between intertidal areas and uplands.

The intertidal-upland ecotone of San Francisco Bay functions as a refuge for intertidal wildlife (Goals Project 1999, Baye 2008), including the endangered California clapper rail and salt marsh harvest mouse (USFWS 2010). It tends to be especially rich in plant species (Goals Project 2000, Baye 2008), although non-native species are often abundant (Fetscher et al, 2009).

This ecotone has been severely impacted by the conversion of tidal wetlands into agricultural lands and commercial salt ponds, and by the filling of marshes for residential and industrial development (Collins and Grossinger 2004). Bayshore development has encroached into or through the ecotone in many areas. Hundreds of miles of levees have been constructed atop the ecotone to protect adjacent land development from extreme high tides. Railroads, pipelines, and transmission corridors commonly trace the ecotone along the bayshore and have disrupted the ecotone to varying degrees. Much of the existing ecotone is now confined to the bayward facing slopes of earthen levees and road grades. The few relatively intact remnants of the historical ecotone have been subject to decades of farming or ranching.

The ecological functions of this ecotone have been gaining recognition within the regional community of natural resource scientists and managers. This is evident by the increasing

number of efforts to restore and protect the ecotone. However, there are scant data about the success of different restoration efforts. Carefully collected data about the success of different plant species at different positions within the zone under different management regimes is needed to inform restoration design. This information can be developed through dedicated research and from restoration projects that use standard methods of data collection to track restoration outcomes. This protocol is intended to meet the need for standardized data about the responses of the ecotone plant community to onsite vegetation management. This protocol can also be used in broader surveys of the ambient condition of the ecotone. Standardized use of this protocol will allow comparisons between local management actions and ambient conditions.

In this protocol, plant community structure is assessed in terms of the abundance of each plant species and bare ground observed during the assessment (i.e., the percent of a specified area of land surface within the ecotone that is covered by each species or bare ground). Information about the abundance of native and non-native species, planted species and other species is automatically developed by the database. These data are particularly useful for characterizing the distribution of common species that make up the bulk of the biomass in the ecotone and less valuable for identifying rare species. These data can also help assess the value of the ecotone as wildlife habitat. If these data are collected at sites before and after they are restored, the data can be used to asses the effects of the restoration efforts.

Many kinds of additional data might be collected along with the data on absolute percent cover of plant species. For example, measures of plant vigor (i.e., plant height, leaf size, amount of flowering or seed-set, etc), plant patch size, and soil fertility provide additional information about plant community structure and site potential that are sometimes more sensitive to management actions than percent cover. At this time, this protocol is restricted to the measure of percent cover to minimize monitoring costs.

With the advent of Global Positioning Systems (GPS) and web-based Geographic Information Systems (GIS), data collection in the field can be integrated with data management and visualization. This protocol is designed to encourage collaborative efforts to learn from restoration projects by standardized applications of conventional scientific methodologies and new Information Technology (IT) to compare projects to each other and over time. This protocol compliments the one for monitoring tidal marsh vegetation (Vasey et al., 2002).

Definition of the Tidal Marsh Ecotone

In concept, the intertidal-upland ecotone is a zone of decreasing tidal influence extending landward from tidal marshland or tidal flat up to or slightly beyond the maximum landward effect of tidal waters on plant community structure. The overall breadth of the zone decreases as its steepness increases. Steep shores have very narrow ecotones. Long alluvial valleys sloping gently to the intertidal zone can have very broad ecotones (Collins and Grossinger 2004). Due to the shape of the tidal curve (i.e., the pattern traced by plotting the rise and fall of the tides over time), plus friction caused by vegetation through which the tidal waters flow, the frequency and duration of tidal inundation decreases exponentially with distance landward through the ecotone. Near the upper limit of the ecotone (i.e., near the top of the tidal curve), large percent changes in the frequency and duration of tidal inundation correspond to slight changes in elevation. That is, the top of the ecotone might be inundated once every few years and slightly higher places are

never effectively inundated. The vegetation of the lower limit of the ecotone tends to resemble the adjacent tidal marsh plain. With distance landward, the vegetation shifts to species indicative of the upper limits of regular tidal action, and then to mixtures of these species and upland species. The upper limit of the ecotone is indicated by only traces of vegetation affected by the tidal waters. The width of the ecotone can be increased by wave run-up, boat wakes, and extreme high tides during storms, and the deposition of salts picked-up from the intertidal zone and carried landward by onshore winds.

     For the purposes of this protocol, the following practical definitions apply.

- The upland ecotone is defined as the area extending bayward from the backshore onto the adjoining marsh plain or tidal flat for a distance of 2.0m, and extending landward from the backshore to whichever of the following two elevation contours is lower: (A) the top of any earthen levee, road grade, or other artificial topographic feature that can support vegetation or (B) an elevation contour 2.0m higher than the nearby marsh plain, or, if there is no marsh plain nearby, 2.5m above the maximum height of adjacent tidal flat.

- The backshore is defined as the approximate landward extent of daily tidal processes that influence the topography of the ecotone and the distribution and abundance of plant species indicative of the local tidal marsh plain. This is usually a topographic contour slightly higher than the local Mean Higher High Water (MHHW) datum.

- A marsh plain is defined as a flat area at least $100m^2$ having essentially uniform slope that is subject to regular tidal inundation and that supports at least 5% cover of vegetation, 75% of which consists of plants restricted to tidal marshes. Tidal flats meet all these criteria except that they lack 5% cover of vegetation. The indicative species of the tidal marsh plain vary with salinity regime. To identify these plant species for any tidal marsh, the interior reaches of the marsh plain equidistant from any tidal marsh channels or pannes must be examined. Typical marsh plain flora for saline and brackish regimes include, but are not limited to, *Salicornia virginica* (pickleweed), *Jaumea carnosa* (fleshy jaumea), *Distichlis spicata* (salt grass), *Juncus balticus* (Baltic rush), *and Triglochin maritimum* (seaside arrowgrass).

  In the case of tidal marsh restoration sites that do not yet support 5% cover of tidal marsh vegetation, the backshore is defined as the landward extent of the non-vegetated tidal flat. Most restoration sites have at least a narrow band of marsh vegetation that can be used to delineate the backshore based on the field indicators provided below (see discussion of Sample Strata in section on Sample Design).

     There are not a lot of data to validate the prescribed upper limit of the ecotone (i.e., see the first bulleted definition in the list of definitions immediately above). A summary of known elevations and ages of tidal marsh plains around San Francisco Bay suggests that they gain elevation as they age, and that the elevations of mature plains range from about Mean High Water (MHW) (marshes between 100 and 200 years old) to about 0.2m above MHHW (marshes much older than 200 years), and that most marsh plains around San Francisco Bay are less than 200 years old (Goals Project 1999). It might therefore be assumed that most marsh plains have an average elevation between MHW and MHHW. Based on the readily available tidal height data from gauges around the Bay that meet federal standards for accuracy and precision (http://ports-infohub.nos.noaa.gov/hq/bench_mark.shtml?region=ca), extreme high water events

(the highest observed water levels) range in elevation from about 0.4m to 1.2m above local MHW, and from about 0.2m to 0.9m above local MHHW, depending in part on tidal range. Higher values are for areas with greater tidal range. Assuming that the *minimum* upper limit of the ecotone is equal to the *maximum* observed water level, and that the marsh plain is about halfway between MHW and MHHW, and assuming a moderate tidal range, then the upper limit of the ecotone probably has a minimum height of about 1.0m above the marsh plain. The National Ocean Survey (NOS) found the average upper limit of salt-tolerant vegetation to be 0.8m above the marsh plain at Point Pinole in San Pablo Bay (NOS 1975). At Palo Alto, Hinde (1954) observed pickleweed (*Salicornia virginica*) at about 1.2m above the average marsh plain. NOS (1975) observed alkali heath (*Frankenia salina)* slightly more than 1.3m above the marsh plain. Based on these data, it seems reasonable to assume that the maximum upper limit of the ecotone, as directly affected by the tides, is probably not more than 1.5 m above the height of the nearby marsh plain, and is certainly not more than 2.0m above the marsh plain. The 2.0m value used in this protocol is further justified by assuming that some minimum amount of upland area higher than the tidally-influenced vegetation is an upward extension of the ecotone, just as the margin of the marsh or tidal flat is a downward extension of the ecotone. With regard to tidal flats, it can be assumed that the lower limit of tidal marsh vegetation (i.e., the upper limit of tidal flats) corresponds to local Mean Tide Level (MTL) (Atwater and Hedel 1976), and that the average difference in elevation between marsh plains (i.e., the elevation midway between MHW and MHHW) and MTL around the Bay is about 0.5m (based on the tidal gauge records). Therefore, the upper limit of the ecotone is probably about 2.5m above the maximum height of the nearby tidal flat (i.e., the marsh plain is 0.5m above the flat, and the top of the ecotone is not more than 2.0m above the marsh plain).

However, tidal marsh vegetation has been observed at elevations greater than 2.0m above the adjacent marsh plain. In uplands sloping gently upward from tidal marsh and subject to strong onshore winds, the lead author has found *Frankenia salina* and salt grass (*Distichlis spicata*) mixed with upland grasses at elevations more than 3m higher than the adjacent baylands. In a recent description of the tidal-marsh-upland ecotone of San Francisco Bay (Baye 2008), field photographs clearly show the ecotone, as defined by distinctive vegetation, extending more than 2m above the marsh plain at China Camp (San Pablo Bay), and elsewhere. Ecotone restoration projects commonly consider the entire bayward faces of shoreline levees as areas of potential ecotone, and these faces commonly extend more than 2m above nearby tidal marshland. Coyote brush (*Baccharis pilularis*) is considered a tidal marsh plant species (Baye 2007), in part because it occupies natural levees along tidal marsh sloughs. It is commonly regarded as a species well-suited for the upland reaches of the ecotone, although it also occurs at much higher elevations. Given these observations, the upper elevation limit of the ecotone as prescribed for this protocol is conservative. It should be revisited as new field data for delineating the ecotone are developed. The upper limit would ideally be defined using local tidal height data collected near the backshore. Such data are very rare at this time.

Personnel

Anyone who can identify wetland vascular plant species and who understands this written protocol should be able to conduct this sampling, if provided with appropriate orientation and supervision.

All field personnel must adhere to practices that ensure their safety and the well being of plants and other wildlife inhabiting the ecotone and adjacent habitats. All personnel must know and adhere to the policies and laws that govern access to, and activities within, the ecotone. For example, access can require written permission to cross private lands, and activities within the ecotone might be constrained by policies protecting threatened or endangered wildlife. Contact local land owners and the Endangered Species Office of the U.S. Fish and Wildlife Service for more information about restrictions and requirements for accessing the intertidal-upland ecotone.

Primary Monitoring Questions

The protocol is designed to answer the following questions.

- What is the plant species richness of the ecotone?

- Which plant species dominate the ecotone?

- How do plant species richness and dominance vary across the ecotone?

- Does plant species richness or dominance vary with restoration design or practice?

- Do the effects of restoration design or practice vary across the ecotone?

When used as directed as part of a monitoring program, this protocol can provide basic information about the status of the plant community of the ecotone in relation to restoration and management practices. If applied consistently over time and from one site to another, it can be used to compare sites, compare restoration and management practices, and to track basic temporal changes in plant community structure. However, it provides little information about such factors as plant vigor, the distribution and abundance of rare plant species, or the wildlife support functions of ecotone vegetation. This protocol could be used to assess such factors if the relevant data were added to this protocol.

This protocol is designed to elucidate spatial and temporal changes in plant community structure of the ecotone, based on standardized monitoring. The monitoring data can be used to develop hypotheses about the causes and consequences of the observed patterns, but are unlikely to be suitable for testing the hypotheses. Understanding cause-and-effect relationships requires specially designed experimentation. This protocol might be used in hypothesis testing, depending on the experimental design.

Monitoring Design

Overview

A stratified-random sampling approach is used to characterize the plant community of the ecotone with regard to the abundance of plant species within 2-4 elevation strata. Additional data on the status of plant species as native or alien, and on site-specific factors such as restoration design, restoration practice, management activities, and salinity regime are derived from the sampling data plus basic information about site characteristics and history.

Assumptions

The underlying assumptions of this monitoring design are listed below.

- Percent cover of plant species varies with elevation across the intertidal-upland ecotone.

- Percent cover of plant species is sensitive to restoration project design and practices, including removal and/or planting of vegetation, fertilization, irrigation, mowing, and herbicide application.

- The relationship between the percent cover of plant species and restoration design and practice varies with elevation across the intertidal-upland ecotone.

Sample Universe

The sample universe (aka sample frame) depends on the purpose of the assessment. For example, when the protocol is applied to an ambient survey, the sample universe consists of all areas of the ecotone within the geographic scope of the survey. When the protocol is used to assess individual restoration projects, the sample universe includes the entire ecotone within the project area that is subject to on-the-ground restoration or management actions. The sample universe of a project can grow as the actions expand across the project area.

Sample Site

A sample site is a continuous portion of ecotone at least 50m long, but not longer than 500m, and having essentially the same width and overall plant community appearance. The following criteria should be used to decide on the end points of a sample site.

- A site *should be* between 50m and 500m long. These are guidelines and not rules.

- The plant community must have the same *overall appearance* throughout. Some variability in plant community structure along a site is expected.

- A site must not incorporate major differences in restoration design or management activities (e.g., differences in irrigation, species removed or planted, etc.), or elapsed time since the management activities were initiated (i.e., all parts of a given site should represent the same stage of plant community development or succession). The complete history of a site is seldom known. But, major differences in historical treatments or impacts should not be incorporated into a site. This is an important criterion for elucidating differences in plant community structure between different practices and different times. If sites include areas subject to different activities, or that represent different periods since the activities were begun, then the differences in plant community between practices and periods cannot usually be discerned.

- Each upland sample stratum within a site (see section title "sample strata" immediately below) must be at least 1m wide to accommodate the standard $1.0m^2$ sampling frame. There is no maximum width for any upland stratum, *but except for the special situation of a very broad ecotone* (see paragraph 3 of Step 4 in section titles "Sample Strata" below), there can be no more than 3 upland strata for any site. Some ecotones are so narrow that they consist of only 2 strata, the intertidal stratum and one upland stratum.

Sample Strata

Each sample site shall be separated into elevation strata. The purpose of these strata is to account for the assumed effect of tidal elevation (i.e., frequency and duration of tidal inundation or wetting), on plant community structure. Without such stratification, the sample data tend to be

too variable to detect differences in plant community over time or between sites. The following procedure shall be used to stratify a site.

1. For each sample site as defined above, identify and mark the approximate location of the backshore. The backshore is an elevation contour; the entire backshore of a site has the same elevation. In concept, the backshore is the landward extent of daily tidal processes that directly affect the topography of a site and the distribution and abundance of marsh plain plant species within the site. Boat wakes, extreme high tides associated with winter storms, and the landward distribution of salt deposited by onshore winds are disregarded in backshore identification. The backshore has a variety of field indicators that should be used together to identify the likely position of the backshore (Figure 1). These indicators include the following.

   - In general, the backshore is slightly higher than the adjacent marsh plain (or tidal flat if there is no adjacent marsh plain).

   - The shoreline often has a wave-cut bench or other break in slope created by tidal action. The top of the bench is usually slightly lower than the backshore.

   - The landward extent to which plants indicative of the marsh plain comprise at least 75% absolute cover tends to indicate the backshore in mature ecotones.

   - Native shrubs such as gum plant (*Grindelia stricta*) and coyote brush (*Baccharis pilularis*) sometimes inhabit the backshore. The bases of the trunks of the lowermost individuals of these species are sometimes a good indicator of the backshore.

   - In the absence of shrubbery, fencing or other obstructions to the landward distribution of wrack (i.e., floating trash, wood and plant debris, and other detritus carried by the tides), the average height of the wrack line tends to be slightly higher than the backshore. Where shrubbery or other obstructions prevent wrack from freely moving landward to the limits of the tides, the wrack tends to settle on the marsh plain and is therefore somewhat lower than the backshore.

   - Independent delineations of the backshore by different workers at a site should not differ from each other by more than 25cm *in height,* relative to the adjacent marsh plain or tidal flat.
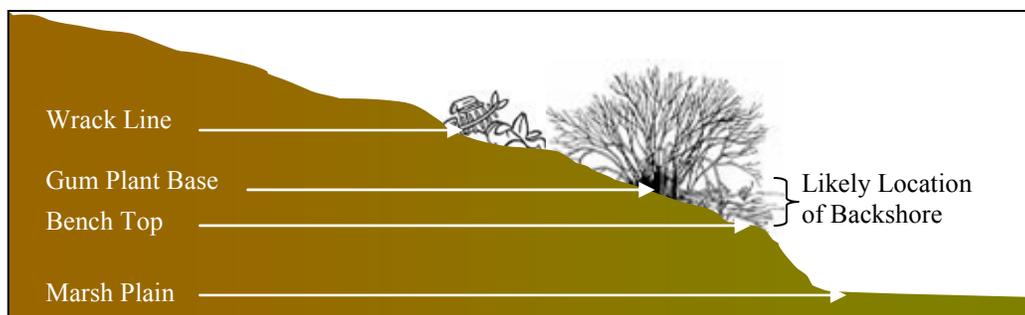

Figure 1: Conceptual diagram of the likely position of the backshore in relation to various field indicators.

2. Determine the <mark>minimum</mark> width of the portion of the transition zone that extends landward from the backshore. Inspect the entire site and locate areas where the width seems minimal. Measure width at these locations by holding a tape in the air parallel to the ground surface between the backshore and the landward limit (i.e., upper edge) of the ecotone. Use more appropriate of the two following alternative definitions of the ecotone to estimate its upper limit.

    The upland ecotone extends landward to whichever of the following two elevation contours is lower: (A) the top of any earthen levee, road grade, or other artificial topographic feature that can support vegetation or (B) an elevation contour 2.0m higher than the nearby marsh plain, or, if there is no marsh plain nearby, 2.5m above the maximum height of adjacent tidal flat.

3. The lower-most stratum of a site always consists of an area of the intertidal marsh or tidal flat 2.0m wide that adjoins and parallels the backshore (Figure 2).

4. This step determines the number of upland strata and their standard width for any site. Most sites will have 3 upland strata of equal width. Divide the minimum ecotone width from step 2 above by 3. If the resulting quotient is between 3 and 10, the upland portion of the ecotone will have 3 strata, each as wide as the quotient. For example, if the upland portion of the ecotone is 3m wide, it will have three upland strata each 1m wide. If the upland portion is 12m wide, each of the three upland strata will be 4m wide.

    If the quotient is less than 3 but greater than 2, divide the overall minimum width of the upland portion of the ecotone by 2, and the upland portion will have two strata, each as wide as the quotient. For example, if the minimum width of the upland portion is 2.75m wide, then it is only wide enough for 2 strata, each of which will be about 1.3m wide (i.e., 2.75/2 = 1.375, rounded to 1.3). If the width is less than 2m, then the upland portion of the ecotone comprises a single stratum.

    Very broad ecotones (i.e., sites where the minimum width of the upland portion of the ecotone is greater than 30m) require special treatment. In the few examples examined thus far, the broadest area of the upland portion of the ecotone corresponds to the lowermost upland stratum. The resulting variability in community structure across this one stratum can increase the variance of the sample data and reduce the ability of the data to discern differences between this stratum and neighboring strata. The solution is to further stratify the stratum. If the upland strata are each more than 10 m wide, based on Step 2 above for determining stratum width, subdivide the lowermost upland stratum into two substrata of equal width (Figure 3).
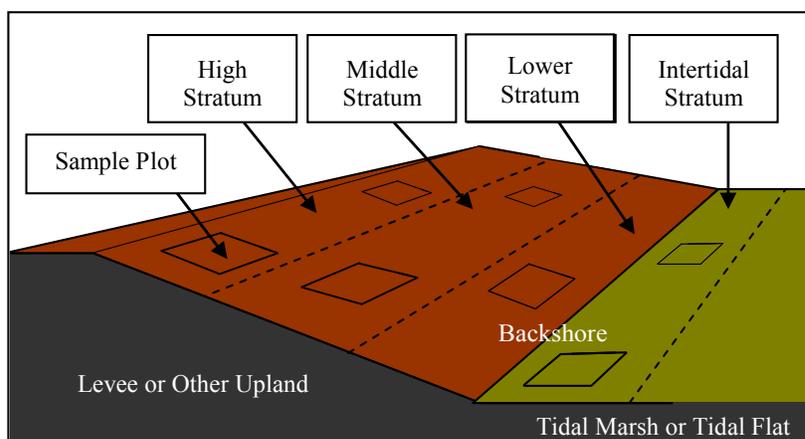

Figure 2: Conceptual diagram of tidal marsh-upland ecotone sample strata, showing some sample plots (black rectangles) in
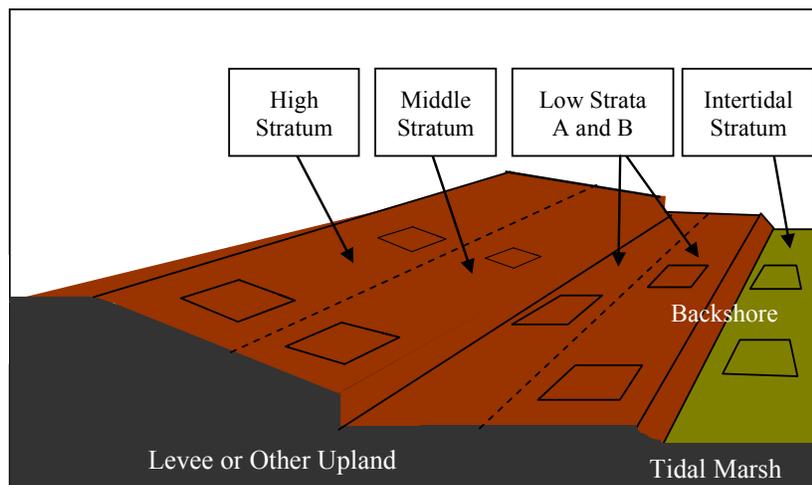
Figure 3: Conceptual diagram of an ecotone with an especially broad low upland stratum, where plant community structure tends to change rapidly with changes in elevation. To minimize the sample variance in this especially variable part of the ecotone, the stratum is further stratified into parts A and B.

Most sites are not completely uniform in their width. The upland portion of a site might be wide enough for three strata in almost all places and two strata elsewhere. As explained in the section below on data collection, the number of strata can vary within a site, so long as the dominant number is based on the minimum width of the upland portion of the ecotone, as instructed in this step.

Sample Plots

Sample plots are square areas 1m^2 in size (100 cm to a side) that are randomly selected within each of the sample strata.

Sample Size and Sample Plot Selection

Sample size is the number of plots per stratum at one site. Sample size can differ between strata at a site, and between sites. The following process for determining sample size is designed to assure that the sample for any given stratum adequately represents the abundance (absolute percent cover) of each common plant species occurring in the ecotone.

Candidate sample plots are randomly selected for each stratum at each site according to either of the two following procedures. This is referred to as the sample draw. One alternative procedure uses high-resolution aerial imagery in a Geographic Information System (GIS). However, use of GIS requires access to it plus GIS expertise that are not essential for this protocol. The field alternative can be used when a GIS is not available.

GIS Alternative

1. In a GIS, draw the boundaries of the sample strata on recent-vintage, 1-m pixel resolution or higher resolution digital aerial imagery (i.e., recent NAIP imagery or suitable site-specific imagery).

2. Using the GIS, create a line down the center of each stratum, and measure the length of these centerlines.

3. Using the GIS, divide the centerline of each stratum into a continuous series of non-overlapping, 1-m long segments. For example, if the stratum centerline is 100m long, it will have 100 1-m long segments.

4. For each centerline, assign a unique alpha-numeric code to each 1-m long segment.

5. For each centerline, determine how many 1-m long segments in aggregate equal 10% of the total length of the centerline. For example, if the centerline is 100m long, then 10 1-m long segments comprise 10% of the centerline length. This is the sample draw size.

6. For each stratum, randomly select the number of 1-m segments equal to the sample draw size. The randomly selected cells equal the sample draw.

7. The middle of each selected 1-m long segment of the sample draw will correspond to the center of a sample plot. Mark the latitude and longitude of the middle of each selected 1-m long segment on the map of each stratum to produce a map of the sample plots.

8. The sample plots can be located in the field by inputting their unique latitude and longitude coordinates as way-points into a Geographic Positioning System (GPS) with 1m horizontal accuracy, or by using the sample plot map from Step 7 immediately above.

Field Alternative

1. Stretch one or more 100-m long measuring tapes graduated in centimeters along the backshore of the site. A 250-m long site will have 2 and one half 100-m long tapes stretched out end–to-end. A 500-m long site will have 5 (five) 100-m long tapes stretched end-to-end. Make sure the tapes follow a single elevation contour, plus or minus about 10cm in elevation. Leave the measuring tapes in place until all the strata are sampled. It is helpful to stake the backshore at regular intervals and to attach the tapes to the stakes above the vegetation. A survey level can be used to stake the backshore.

2. Determine the sample draw size based on the length of the backshore in meters (i.e., the length of the site). If the entire backshore is 100-m long (i.e., if the site is 100m long), each stratum will have a total number of 100-1 = 99 possible plots (the 100-m distance is excluded). The sample draw size equals 1/10 (one tenth) of the site length. If the backshore is 100m long, then the sample draw size is 10. If the backshore is 500m long, the sample draw size is 50.

3. Randomly select the plots for the sample draw. One method is to separately number equal-size slips of paper from 1 to the number equal to the length of the stratum in meters minus 1 meter (i.e., if the stratum is 100m long then separately number 99 pieces of paper from 1 to 99); mix the pieces of paper thoroughly in a hat or other suitable container; withdraw the number of slips equal to the sample draw size (as determined in Step 2 immediately above). Each selected slip of paper identifies the location of one sample plot in the sample draw for one stratum, in terms of its distance in meters along the backshore.

Withdraw the slips of paper one at a time, and record their numbers in the order in which they are withdrawn.

4. Repeat steps 1-4 for each stratum of each site. It is essential that a separate sample (i.e., a separate set of sample plots) be drawn for each stratum. Note that all the strata will have the same length, and will therefore also have the same number of sample plots (i.e., Steps 1 and 2 only need to be done once per site), but the locations of the plots that are actually used will not necessarily be the same for any two strata because the plot locations are randomly selected separately for each stratum.

   Note: for any given site, the sample strata will stay the same from one sample period to another, but each sample period will require a new sample draw for each stratum.

Finalizing the Sample

Finalizing the sample means deciding how many plots from the sample draw have to be collected within each sample stratum to adequately represent its plant species richness and the abundance of the common plant species. It is not likely that the entire sample draw will have to be used to meet these objectives. The sample is finalized separately for each stratum.
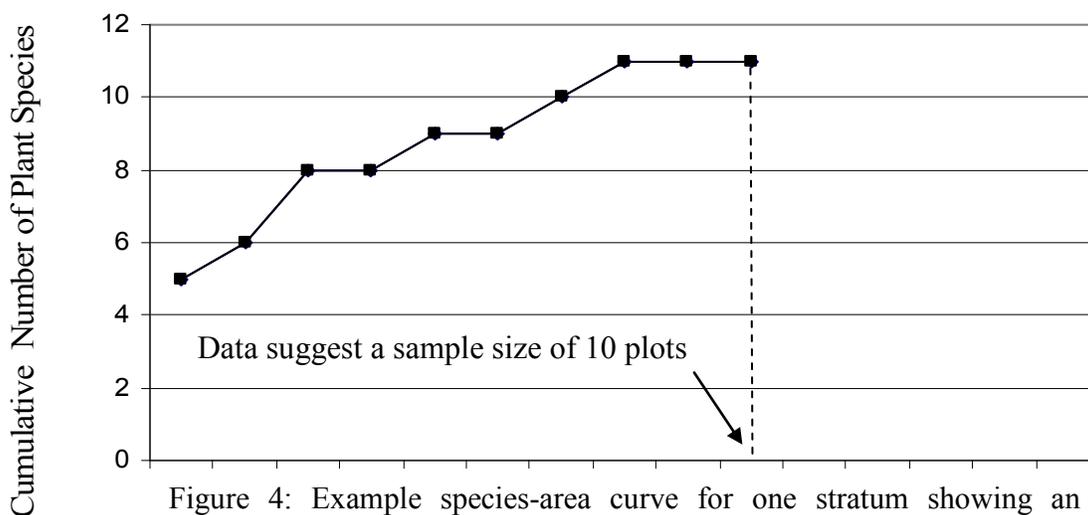

Figure 4: Example species-area curve for one stratum showing an asymptote at eight sample plots, indicating that for this stratum only 8 plots are needed.

The sample is finalized as data are being collected. Finalizing the sample is part of data collection. The process of finalizing the sample is explained separately here, but is actually integral to data collection, which is outlined in the next section of this protocol.

1. The sample plots for each stratum are visited in the order in which they were selected into the sample draw. The first plot randomly selected is visited first, regardless of where it is along the stratum. The plot selected second is visited second, and so on.

2. The last kind of data collected at each plot is the total number of "new" species occurring at the plot. "New" species are species that have not been observed in previous plots within that stratum. All the species occurring in the first plot are counted as "new."

3. As data collection proceeds from one plot to the next within a stratum, a graph is constructed showing the cumulative number of "new" species observed (Figure 4).

4. Sampling stops for a stratum when the number of "new" species does not change for three consecutive plots (Figure 4). This means that each stratum will have a minimum sample size of 3 plots.

5. The data on abundance (i.e., absolute percent cover) for all the plots within a finalized sample are used to identify the dominant plant species, using the following method adopted from the US Army Corps of Engineers (USACE 2008). This step will be conducted after the data have been collected.

   A. For each species, add together the plot-specific values for absolute percent cover. There should be one value for each species in the sample for each stratum.

   B. For each stratum, add together the species-specific values from step 5A above.

   C. For each species, divide its value from step 5A by the value from step 5B. Each species will thus have a single percent cover value for the stratum as a whole.

   D. List the species in descending order of their percent cover, using the values for each species calculated in step 5C above.

   E. Starting at the top of the list from step 5D above, and proceeding consecutively down the list, select the species that, when their values for percent cover are added together, the sum exceeds 50%. These are considered dominant species. If the first species has a cover value ≥ 50%, it is a dominant species. All species of equal cover value that contribute to meeting this requirement must be selected.

   F. Identify any other species that by themselves have an overall percent cover for the stratum as a whole of at least 20%. These are also considered dominant species.

6. The percent cover data for the species identified as dominant in step 5D and 5E above are used in a power analysis to determine whether the sample size determined based on the species-area curves is adequate to be either 80% or 95% certain of estimated differences in percent cover between any two strata for any observed plant species.

Data Collection

Data collection entails field-based measurements of the selected parameters of plant community structure for all the sample plots during one sample period. For each site, the following sampling steps shall be conducted in the following order.

1. Begin data collection at the first plot selected into the sample draw for the intertidal stratum. Locate the distance along the tape measure that corresponds to this first plot.

2. At this location along the tape, extend a second tape 1.0 m perpendicular to the backshore onto the marsh plain.

4

3. A square plot frame having an area of $1m^2$ (100 cm per side) is carefully lowered onto the marsh plain, such that the 1.0m mark of the tape is at the center of the frame, without undo disturbance to the plant cover within the plot or around it. Do not disturb the

adjoining upland stratum. Each intertidal stratum plot should cover the distance across the marsh plain from 0.5m to 1.5m away from the backshore.

4. Collect the following data for the first sample plot.

    a. Visually estimate the absolute percent cover of bare ground and each plant species in the plot. Bare ground can be represented by either or both of two kinds, fine textured or coarse textured (see datasheet). Since plant species can vertically overlap, their values for absolute percent cover can sum to more that 100% for each plot.

    b. Each species observed is classified as (1) native or non-native according to the Jepson Manual (Hickman, 1993); (2) planted or not planted based on site-specific list of planted species; and (3) removed or not removed based on a site-specific list of species that were removed. Planted individuals are not assessed separately from naturally recruited individuals. The net effect of recruitment can be assessed as the difference between the first and subsequent samples.

    c. The visual estimates of absolute percent cover greater than 3% are rounded to the nearest 5%. Values ≤ 3% are rounded to the nearest 1%.

    All field personnel who are collecting data to compare strata within or among sites must be calibrated to each other. This means that each person independently estimates absolute percent cover for each species in the same calibration plot; that the participating personnel compare their estimates; that they confer with each other regarding any differences greater than 5 percentage points for any species having an absolute percent cover value > 3%; and that they repeat the process on additional calibration plots until no two estimates for the same species in a plot differ by more than 5 percentage points.

    d. All data must be recorded on the standard datasheet for this protocol (see attached datasheet).

5. Complete steps 1-5 of the section above titled "*Finalizing the Sample*".

6. Complete all the sampling in the intertidal stratum before proceeding to an upland stratum. Complete the sampling in one upland stratum before proceeding to another.

7. To sample an upland stratum, go to the distance along the tape at the backshore that corresponds to the first plot selected into the sample draw for that stratum. Extend a second tape uphill and perpendicular to the backshore to the middle of the upland stratum being sampled. Carefully center the sample frame on the end of the second tape, such that the downhill edge of the frame is parallel to the backshore (Figure 5). Collect data from the plots according to Steps 4 and 5 immediately above.
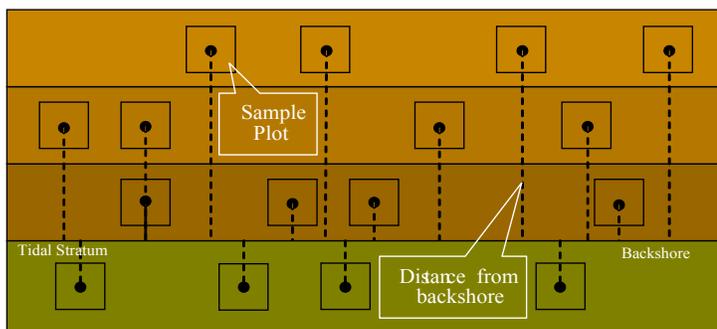

Figure 5: Schematic diagram of arrangement of sample plots within each stratum at randomly selected distances along the backshore. The distances are randomly selected for each stratum

Sample Timeframe and Sample Period

The sample timeframe is the time of day and time of year when the field data should be collected. All data should be collected after most of the perennial vegetation has added its annual biomass and before annual vegetation has senesced. The data for the intertidal stratum should be collected at a time of day when the stratum is not inundated with water.

The sample period is the portion of the timeframe when data are actually collected. All data for all strata and sites should be collected during the shortest period possible to maximize their comparability.

For the purpose of assessing the effects of management activities, baseline data should be collected before the activities ensue and annually thereafter. The length of the monitoring effort (i.e., the number of years of monitoring) will vary from project to project.

Basic Field Equipment

- ✓ 100m transect tape to lay along the backshore
- ✓ Survey level for sighting the backshore
- ✓ 25m transect tape for locating sample plot centers perpendicular to the backshore
- ✓ 1m^2 plot frame divided into 100 equal-size cells (10cm to a side)
- ✓ GPS unit
- ✓ Camera
- ✓ PVC markers and hammer
- ✓ Plant press for collecting reference specimens
- ✓ Data sheets

Data Analysis and Interpretation

The species-area curves used to determine the final sample size will be developed in the field, as the data are being collected. A datasheet for this purpose is attached. Whether a species is native or alien will be determined automatically by the database. The database will also automatically identify the dominant species for each stratum of each site, and for each site as a whole, using the modified version the USACE 50/20 rule.

The power analyses needed to assess the adequacy of the final sample size for determining the differences in species abundance between strata or between sites, given the sample size determined from species-area curves, will be conducted after the data are collected.

Since ecotone width can vary among sites, the number of strata might also vary among sites. Also, since the number of plots needed to assess species richness can vary among strata,

the number of plots might vary among strata as well as among sites. These differences in sample design do not influence the comparison of one stratum to another within a site, one stratum or site to itself over time, or the comparison of sites that have the same number of strata. But, they do limit comparisons between sites having different numbers of strata, as explained below.

Consider the situation illustrated by Figure 6. Site A and Site B are adjacent to each other and therefore subject to the same tidal regime. The intertidal strata of the two sites are comparable because they represent the same marsh plain. However, since the upland strata are delimited by equally subdividing the upland portion of the ecotone at each site, it is possible for two adjacent sites of different width to have different numbers of upland strata. In this example, Site A is wide enough for three upland strata (labeled 1-3), whereas Site B is only wide enough for two uplands strata (labeled 1 and 2). Because of the difference in slope between the two sites, all of stratum A2 is lower in elevation than stratum B2. This means that Stratum A2 is inundated more frequently than stratum B2. The plant communities of these two strata are therefore likely to be different. In general, sites with different numbers of upland strata should be compared based on their intertidal strata, and based on the overall condition for all upland strata combined, and not on the basis of individual upland strata. This limitation could be eliminated by delimiting the upland strata based on the frequency of tidal inundation, but the required tidal data do not exist for most sites.
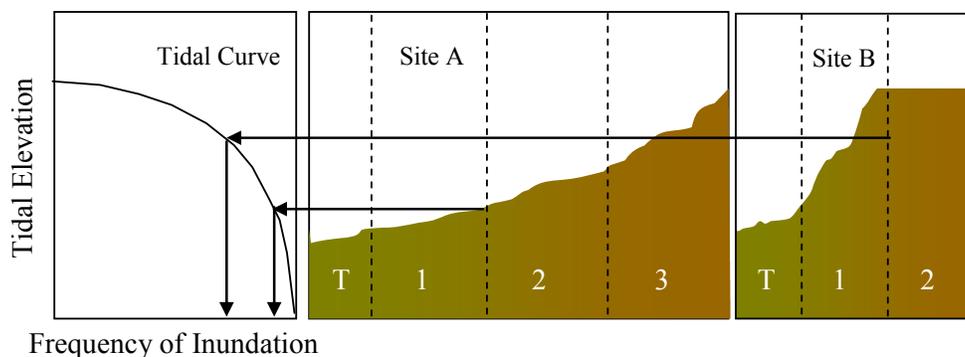

Figure 6: Schematic diagram of two hypothetical adjacent sites A and B having different numbers of upland strata that represent different inundation regimes. For example, stratum A2 is lower than stratum B2, and is therefore inundated more frequently.

The data generated by this protocol are categorical. That is, they describe conditions within discrete portions of the ecotone, called sample strata. Based on this protocol, each stratum will have a population of data points with a mean and variance that can be used to statistically test for differences between strata at a site, between different time periods for the same stratum at a site, and between comparable strata of different sites. The appropriate statistical tests for these comparisons will be analyses of variance. Relationships between two or more parameters measured at the same plots can be explored using regression analyses (Figure 6).

Each stratum and site will be analyzed in terms of species richness, the frequency of occurrence and absolute percent cover of each dominant plant species and bare ground, and absolute percent cover of non-native dominant species. The results can be used to assess how the distribution and abundance of plant species indicative of the tidal marsh plain vary among sites, and how the plant community varies with distance above adjoining marshland or tidal flat. The

degree to which these patterns correlate to site-specific factors, including ecotone width, salinity regime, restoration design, and management practices, can also be assessed. Such assessments can help determine which plant species are best suited for each elevation stratum within and among sites, and to determine which restoration and management practices are more effective.
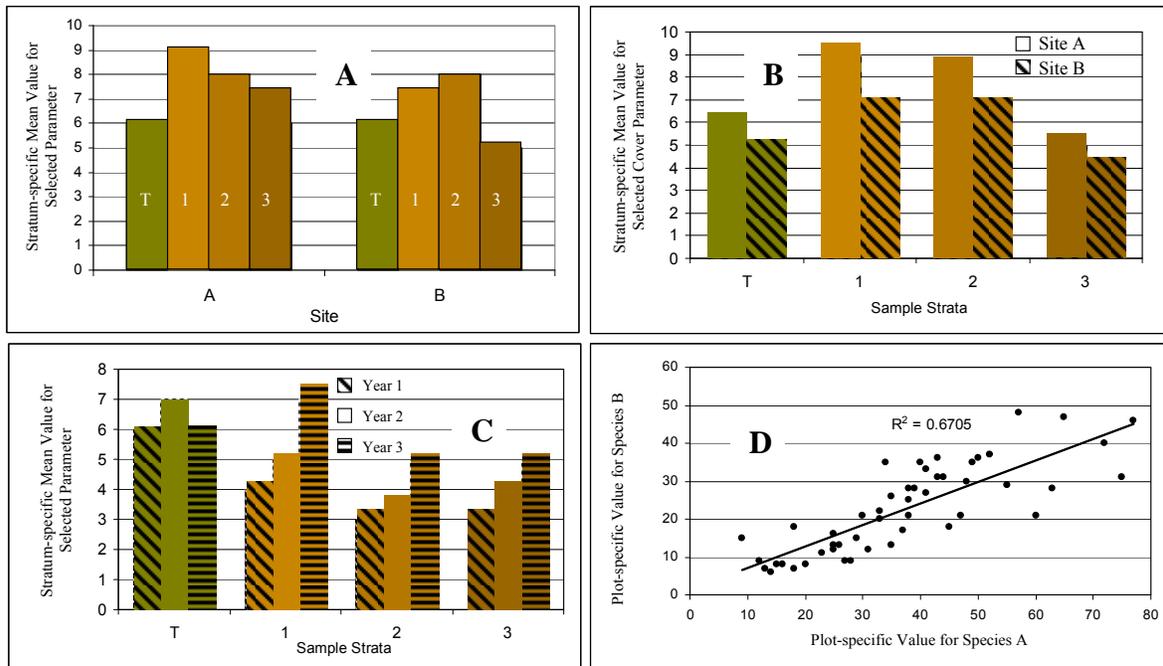

Figure 7: Example plots of hypothetical results showing (A) comparison of two parameters at one site; (B) comparison of two sites based on one cover parameter; (C) changes over time for one parameter at one site; and (D) correlation between two dominant plant species at one or more sites.

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Intertidal – Upland Ecotone Plant Community Monitoring Data Sheet　　　Page ___ of ___

Project Name: _____　**Begin UTM:** _____　**Field Staff:** _____

Sample Site Name: _____ _____　**End UTM:** _____　_____

Sample Site Code: _____　**Begin UTM:** _____　_____

Date: _____　**End UTM:** _____　_____

Start Time: _____　**End Time:** _____　_____

Stratum	Sample Plot	Species Code	Absolute Percent Cover	Comments

Biotic Cover Code:
Plants: first three letters of genus and first letter of species (e.g. SALV for *Salicornia virginica*).

Sessile animals (shellfish etc): SA

Abiotic Cover Code:
Fine Bare Ground (FBG): diameter of most particles ≤ 2mm

Coarse Bare Ground (CBG): diameter of most particles > 2mm

Strata Codes:
From low to high elevation: Tidal (T), Upland A (UA), Upland B (UB), Upland C (UC); there are normally three upland strata (UA-UC)

Sample Plot Code:
3 letter acronym of site name, first letter of Strata code, and plot number (e.g. MLKT1, MKLT4, MLKUA3, MLKUA1, MLKUC3, etc)

Intertidal – Upland Ecotone Plant Community Species Area Curve

Project Name: _____
_____

Sample Site Name:
Sample Site Code: _____

Sample Date: _____

Stratum Code: _____

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
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Consecutive Sample Plots Starting with the First Selected into the Sample Dr

QUALITY ASSURANCE PROJECT PLAN

SAVE THE BAY SALT MARSH TRANSITION ZONE COMMUNITY-BASED RESTORATION

SALT MARSH TRANSITION ZONE NATIVE PLANT MONITORING

Save The Bay
350 Frank Ogawa Plaza, Suite 900
Oakland, CA 94612

Approved by Project Manager: Date:

_____

Approved by Project QA Manager: Date:

_____

Approved by Region 9 Quality   Date:

Assurance Manager:

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Approved by EPA Project Manager: Date:

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SAVE THE BAY

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PROJECT DESCRIPTION

1.1.   Project Purpose and Problem Definition

The Save The Bay salt marsh transition zone community-based restoration and salt marsh transition zone native plant monitoring projects' goals are to restore and enhance vital San Francisco Bay tidal marsh habitat to increase coverage for sensitive species as well as connectivity between habitats, while providing a unique opportunity to educate and engage community members in important stewardship activities. To adaptively restore these habitats, Save The Bay will use lessons from native plant monitoring to adjust the efficiency and efficacy of these restoration activities and techniques. Lessons learned here will be utilized for future transition zone restoration region-wide.

As a leading organization in community-based salt marsh transition zone restoration, Save The Bay's restoration work utilizes ten years of volunteer/citizen based restoration to plant native vegetation in zones that cannot easily "self restore" through tidal influence, yet are essential to reinstate the ecosystem level functions tidal salt marshes provide for the San Francisco Bay.

The main objective of this project is to increase native plant coverage in mid-high marsh and riparian zones to provide refuge during high tide and storm events for native fish and other sensitive wildlife. The project will also improve stream bank stabilization and create a substantial increase in native plant coverage to provide detrital food resources to enhance a sustainable bay fisheries food web. Save The Bay's restoration incorporates scientific methods to effectively mitigate the effects of invasive weed species on tidal marsh habitat through a combination of weed removal, native planting, long-term maintenance of restoration sites, monitoring plant coverage and plant growth, and education of community members and land partners. Save The Bay applies an integrated multi-tooled invasive eradication and prevention approach, including adaptive weed management through site surveys, minimization of soil disturbance, specific, ongoing and adaptive education of community members and site partners, revegetation with natives and anticipation and mitigation of erosion and wildlife disturbance effects.

Native plants are essential in these areas to provide sensitive species refuge from predation and human disturbance. Studies of wildlife corridors also suggest that connectivity between habitats is crucial for sustainable wildlife populations such as the endangered salt marsh harvest mouse and California clapper rail, the threatened snowy plover and other migratory and residential waterfowl and shorebirds.

This Quality Assurance Project Plan presents functions and procedures to meet the objects of the monitoring and analysis of the native plant communities at the Save The Bay salt marsh transition zone restoration sites. This work will be performed by Save The Bay restoration experts. The monitoring protocol presented here is designed to assess the progress towards, and the success or failure of Save The Bay's salt marsh transition zone habitat restoration projects. The monitoring is also aimed to assess the achievement of acceptable standards of salt marsh ecological function. The Save The Bay Native Plant Monitoring Program will implement long-term vegetation monitoring of restoration sites to evaluate the success of restoration efforts. Field parameters will be measured at each sampling site. A list of parameters of interest is included in Attachment A

The tidal marsh-upland transition zone of San Francisco Bay functions as a refuge for intertidal wildlife (Goals Project 1999), including the endangered California clapper rail and salt marsh harvest mouse (USFWS 1984). It tends to be especially rich in plant species (Goals Project 2000), although non-native species are often abundant (Fetscher et al, 2009).

This area of the Bay ecosystem has been severely impacted by the conversion of tidal wetland into agriculture and salt ponds or filled them for residential and industrial development (Collins and Grossinger 2004). Bayshore development historically encroached onto the transition zone or levees were constructed atop the zone to protect the adjacent development from extreme high tides. Railroads, pipelines, and transmission corridors are commonly associated with the transition zone and have disrupted this zone to varying degrees. The most intact remnants of the historical zone have been subject to decades of intensive grazing. Much of the existing zone consists of the bayward slopes of levees and road grades.

The regional community of natural resource managers, scientists, and conservation groups has recognized the ecological value of the tidal marsh-upland transition zone and has begun restoring it. However, there are scant data about the success of different restoration approaches and plans. Carefully collected data about the success of different plant species at different positions within the zone under different management regimes is needed to inform restoration design. This information can be developed through dedicated research and from restoration projects that use standard methods of data collection. This protocol is intended to meet the need for standardized basic data about transition zone vegetation.
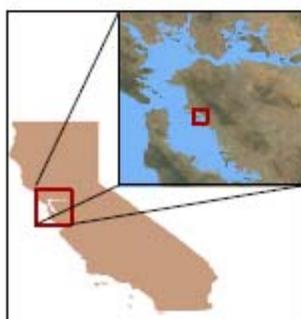

1.2.   Project Area Description

Save The Bay's transition zone restoration focuses on habitat between tidal marsh and upland riparian zones along the San Francisco Bay Estuary. The project described here focuses on restoration of two sites along the south-eastern shoreline of the San Francisco Bay.

The Martin Luther King Jr. (MLK) Shoreline in the Oakland Estuary includes the mouths of five major creek systems and includes one of the largest stands of wetlands in Oakland, a 50-acre tidal wetland called Arrowhead Marsh) as well as a stretch of Damon Slough. Our project site includes the shoreline, creek mouths and a 72-acre area of bayfill that is being restored to tidal salt marsh. We have four distinct project sites, including levees boarding the 72 acre wetland restoration site, and two sites on Damon Slough to the north. Our efforts are to reestablish native vegetation of these wetlands by removing invasive species, collecting site-specific native seeds, propagating native plants, outplanting, and monitoring (Figure 1.2a and 1.2b). We operate an on-site native plant nursery and will engage 441 volunteers in the full cycle of plant propagation. The Martin Luther King Jr. Shoreline Park is part of the East Bay Regional Park District and is open to recreational activities such as picnicking, birdwatching, hiking, and fishing.

Our second site is within the California Department of Fish and Game Eden Landing Ecological Preserve. Eden Landing is a 6000 acre parcel of former salt ponds that is in the process of partial restoration to tidal wetlands. It provides habitat connectivity between the Hayward Regional Shoreline, Coyote Hills, and Don Edwards refuge areas in Hayward. Our restoration efforts here are along a degraded 3 mile levee (Figure 1.3) on the eastern portion of the 600 acre Baumberg Pond.

Figure 1.2a. Martin Luther King Marsh Restoration Area. Restoration area is highlighted in blue
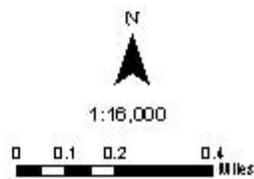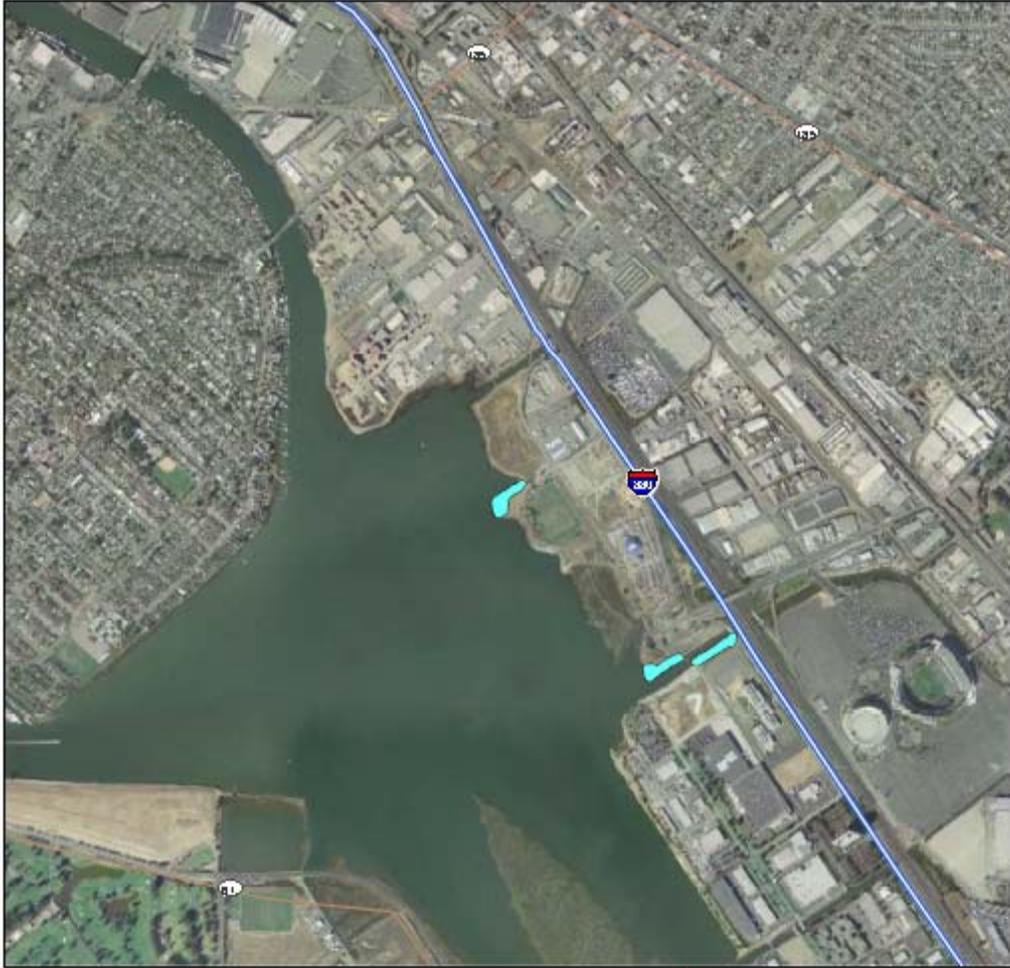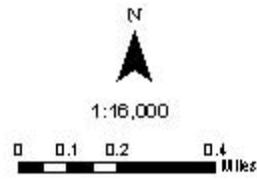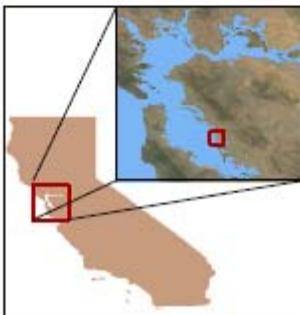

Figure 1.2b. Damon Slough Marsh Restoration Area. Restoration area is highlighted in blue.

SAVE THE BAY
Community-Based Restoration

MLK Damon Slough

N

1:16,000

0   0.1   0.2   0.4
                              Miles

Data Sources: ESRI, Save The Bay
Datum: NAD 1983 Projection: Teale Albers
Compilation Date: July 21, 2009
Created by: M. Klasc (SFEI) and L. Weiner (Save The Bay)

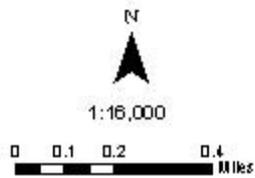Figure 1.3. Eden Landing Marsh Restoration Area. Restoration area is highlighted in blue.

1.3.   Responsible Agency and Participating Organizations

The Save The Bay tidal marsh native plant restoration and monitoring will be conducted by trained Save The Bay biologists. The Save The Bay Finance and Development Departments will manage the contracting of monitoring for this project. The key personnel are:

Title	Name	Phone	email
Habitat Restoration Director	Darcie Collins	510.452.9261 x 110	darcie@savesfbay.org
Projects Manager	Laura Wainer	510.452.9261 x 116	lwainer@savesfbay.org
Native Plant Nursery Manager	Denise Della Santina	510.452.9261 x 11	denise@savesfbay.org
Field Specialist	Melanie Lopes	510.452.9261 x 11	mlopes@savesfbay.org
Finance Director	Robin Erickson	510.452.9261 x 11	rerickson@savesfbay.org

1.4.   Project Organization Roles

Dr. Darcie Collins, Save The Bay's Habitat Restoration Director, is responsible for preparing and maintaining the QAPP for all work performed under contract and acts as the Quality Assurance (QA) officer, overseeing field monitoring activities and data analysis. The Projects Manager is also responsible for overseeing review of the project QA/QC.

The Native Plant Nursery Manager is responsible for keeping the Habitat Restoration Director aware of all native plant conditions and for oversight of monitoring activities. The Field Specialist is responsible for all data entry and monitoring logistics. The Field staff are responsible for planting and non-native plant removal.

Title/Responsibility	Name/Qualification	Agency Affiliation	Number/email
EPA project officer/Oversees Direction of Project	Luisa Valiela	**EPA**	(415) 972-3400 **Valiela.Luisa@epamail.epa.gov**
Project Manager/Directs Day-to Day Work of project	Dr. Darcie Collins, PhD in Estuarine monitoring and management, 12 years experience in wildlife monitoring and management. Monitoring training through SFEI	**Save The Bay**	**510.452.9261 X 110 Darcie@savesfbay.org**
Staff/Performs Project Tasks	Laura Wainer: Project Manger, Masters in Wetland Science, 7 years experience,	**Save The Bay**	

	Monitoring training through SFEI Denise Della Santina: Native Plant Nursery Manager, 15 years experience in native plant propagation, Monitoring training through SFEI Melanie Lopes: Field Specialist, 5 years in restoration and education. Four field staff (Megan Hess, Megan Kelso, Dylan Chapple, and Jill Jacobson). All staff have at least three years experience in tidal wetland restoration and field education.		

1.5. Permits for Collection

Save The Bay holds current seed collection and Special Use Permits with all Land Partners. All permits are renewable and are renewed on a yearly basis. These permits are included as Attachment C and include:

- East Bay Regional Parks Special Use Permit
- East Bay Regional Parks Service Seed Collection Permit
- USFWS Seed Collection Permit

1.6. History, Previous Studies, Regulatory Involvement

As a leading effort in Community-based restoration, Save The Bay is utilizing ten years of volunteer/citizen based restoration experience, statistics, and ecological data to provide best practices and guidance to the tidal salt marsh and community-based restoration communities. Through data analysis and qualitative evaluations, STB is creating a community-based restoration program that efficiently uses volunteer and staff resources to effectively restore transition zone habitat

Save The Bay's Community-Based Habitat Restoration Program focuses on enhancement and revegetation of transition zones, specifically the unique band of habitat above the mean high tide line in salt marsh habitats which does not re-establish voluntarily following tidal restoration. Because native plant species diversity has been greatly reduced around the Bay through bay fill, erosion, pollution and water diversion, we focus on establishing greater vegetation diversity and cover in the mid-high marsh zone adjacent to the wetlands. In San Francisco Bay, mid-high

marsh native plants provide habitat and cover during extreme high tides, flood and storm surge for native shorebirds and other threatened and endangered wildlife.

Many scientific studies and restoration projects provide evidence that tidal marsh plant species voluntarily reestablish following the reinstatement of tidal flow in previously altered tidal wetland habitats (Williams & Orr, 2002). Tidal waters provide a rich seed bank that disperses into these newly established areas. Natural salinity ranges also reestablish rapidly following the regular flow of Bay water. Common South Bay invasive plants have lower survivorship when submerged in saline tidal water, reducing infestations in the low marsh zone. Most emphasis on marsh restoration in the San Francisco Bay has focused on the intertidal (below mean high tide) marsh plain, which is dominated by pickleweed or cordgrass in the first stages of succession. In San Francisco Bay, these transition zones are often levees built with non-native soil in which native plant growth is minimal. These levees are often characterized by steep grading, highly saline soils from former salt production, and visible shifts in vegetation types. Invasive plants such as *Mesembryanthemum crystallinum (*crystalline iceplant) *Foeniculum vulgare (*fennel) have taken over many of these transition zones and outcompete native species. These zones are also often disturbed by levee maintenance activities and are used as roads or trails with permanently disturbed edges and bare, unvegetated tops. Undisturbed, functioning transition zone habitat would serve as high tide flood refuge habitat for resident marsh wildlife by providing cover from predators. Therefore, unmanaged, these terrestrial-estuary transition ecotones usually inhibit the full potential of returning full ecosystem functions of tidal marsh restoration.

Native plants are essential in these areas to provide refuge for these species from predation and human disturbance. Studies of wildlife corridors also suggest that connectivity between habitat is essential for sustainable wildlife populations. Connecting these zones is therefore an important aspect of tidal wetland restoration. Restoring these transition zones also provides buffer from sea level rise associated with climate change. Vegetation buffers act as natural flood controls in these areas.

2.0   PROJECT DATA QUALITY OBJECTIVES

2.1   Data Quality Objectives
The over all goals of the STB Community-based Restoration Program are to:
- Return the Bay to an ecologically functioning and diverse ecosystem
- Increase the cover of native plant species in the Bay and decrease the amount of non-native invasive species
- Educate community members and enable them to become environmental stewards

The main metric for this project is monitoring and assessment of the performance of the project's design to increase the relative abundance of plant species native to the transition zone between intertidal marshland and uplands. STB will use a suitable protocol for assessing long-term regional trends in the health of the transition zone through ambient surveys, and the effects of human activities on conditions within the zone at particular sites. For example, this protocol can be used to assess conditions before and after efforts to remove non-native vegetation and/or to plant native vegetation. Project outputs and monitoring variables include native and non-native plant coverage. A protocol for measuring these variables is included as Attachment A.

**2.2	Data Quality Indicators for Field Activities**

A stratified-random sampling approach is used to characterize the plant community of the transition zone with regard to three parameters:

- Overall species relative abundance;

- Species abundance within elevation strata;

- Maximum height of species; and

- Percent cover of native and non-native species.

Assumptions

The underlying assumptions of this approach are:

- The indicators of plant community structure are sensitive to restoration project design and management practices, including removal and/or planting of vegetation, fertilization, irrigation, mowing, and herbicide application.

- The response of these indicators to management actions can vary with elevation above the adjacent zone.

Indicators

Representativeness: The degree to which the data is representative of a characteristic of a population, parameter variations at a sampling point, or an environmental condition is called the representative value of data. Data are considered representative if the sample distribution is in accordance with the sampling programs defined in the appropriate sections of the work plan. The project design and monitoring reflects the true population of the sample areas. This monitoring protocol is randomly stratified which increases representativeness by ensuring equal chance of selection for entire project area. This decreases the chance of bias, and increases the representation of the true population.

Comparability: Using standardized planting and monitoring methods will increase comparability within and across projects and allow for a systematic assessment of data and information. Comparability of field data sets will be accomplished by ensuring the proper training of all field personnel.

Completeness:

Completeness is defined as the percentage of the total measurements made which are judged to be valid measurements. The completeness objective is essentially the same for all data uses: that a sufficient amount of valid data will be generated to enable the objectives of the project to be achieved. We have determined that to achieve our objectives, we will monitor the project site according to the following protocol. Each sample site shall be separated into four elevation strata. We will then determine the sample size of each elevation stratum, which will account for 10% of the stratum area, using the following formula:

stratum area x 0.1 = sample size; round to the nearest whole integer.

We expect a completeness of 85 to 90%.

Precision: Precision is the agreement among independent measurements of the same parameter at the same location. Precision in the field will be assessed by replicate measurements.

Accuracy: Goals for accuracy will vary greatly depending on the parameter being measured. Accuracy is also ensured by field training to be sure that all personnel follow the same procedures. Accuracy in identification of species will also be improved through unknown specimen verification (see section 3.2).

2.3   Data Review

All field data will be reviewed, verified, and validated by Darcie Goodman Collins, PhD or Josh Collins, PhD. Any problems or discrepancies with the data will be reported and made available through Wetlands Tracker. This will be done each year following field data collection. This will be accomplished by reviewing data sheets and training records generated in the monitoring year. In addition, the trained staff who participated in the monitoring events, will meet before the previous years data are released to review the data and notes made by field staff and volunteers collecting data. If data quality concerns arise, steps will be taken to correct the methodology, application of the methodology or any other process that lead to the errors. The QAPP will be adjusted if necessary.

2.4   Data Management
Data Collection

Data collection entails field-based measurements of the selected parameters of plant community structure for all the sample plots at a project during one sample period. This data collection will occur in March of each year prior to, during and following restoration activities. For each randomly selected $1.0m^2$ sample plot, the following sampling steps shall be conducted in the following order.

1. A $1.0m^2$ wooden or plastic frame (100 cm per side) is centered over each selected plot location and carefully lowered onto it without undo disturbance to the plant cover.

2. Percent absolute cover (i.e., the percent of the plot) is estimated for all non-vegetated areas combined within the frame. Bare ground and litter-covered areas are estimated separately.

3. Percent absolute cover for each plant species is also estimated separately. Visual estimates of cover are made using a modified Daubenmire cover class system (Daubenmire 1959) using a 7-point scale, as indicated below. Because plants may overlap, cover estimates may total more than 100%.

Estimated cover categories	Cover class
>0-1%	1
>1-5%	2
>5-25%	3
>25-50%	4
>50-75%	5
>75-95%	6
>95-100%	7

4. Height (to the nearest cm) of the tallest individual of each plant species. Height is measured without straightening or otherwise manipulating any vegetation.

5. Each species observed is classified as native or non-native, according to the Jepson Manual (Hickman, 1993).

Data Storage

All data will be entered into excel databases and into the web-based database, Wetlands Tracker within 4 weeks of analysis. Data will be checked against data sheets yearly in order to check the accuracy of the data entry. All data will undergo final inspection by the project quality assurance personnel before submission.

Data Analysis

Data will be analyzed per stratum and site. Each stratum will be analyzed for frequency of occurrence of each species, average cover per occurrence of each species, and maximum plant height per species. These data can then be used to determine how the project is affecting the distribution and abundance of plant species within the transition zone, including percent native and non-native species, and how these effects vary with distance away from and above the adjoining tidal marsh or tidal flat. This will assist in determining which sub-zones are best suited for which plant species. Use of this protocol by different projects will, over time, provide a basis for assessing the interactions among plant species, tidal regime, and vegetation management practices.

2.5 Assessment Oversight
This section is not applicable.

2.6 Acquired and/or Secondary Data or Non-Direct Measurements
Data acquired prior to the approval of this project measuring pounds of invasive species removed from restoration sites was collected by field staff immediately following removal activities. Invasive plants are removed from site using either biodegradable bags or reusable woven plastic bags. Bags are weighed on site using a hanging scale. Pounds of invasive removed per program are recorded and input into our excel database.

3.0   FIELD STUDY DESIGN/MEASUREMENT PROTOCOLS

3.1   Physical Characteristics

The transition zone is defined as the area of land straddling the backshore of the intertidal zone that extends bayward from the backshore onto the marsh plain for a distance of 2.0m, and that extends landward from the backshore to whichever of the following two heights is lower: (A) the bayward edge of the top of any levee, road grade, or other artificial topographic feature that intercepts the zone with substrate that can be colonized by plants; or (B) a natural elevation contour 3.0m above the height of the adjacent vegetated tidal marsh plain, or 3.5m above the height of the adjacent tidal flat, if there is no adjacent vegetated marsh plain (Figure 1, Attachment A).

The backshore of the intertidal zone is defined as the approximate landward extent of either the tidal marsh plain or tidal flat, whichever adjoins the upland. The tidal marsh plain is defined as the area that is subject to regular tidal inundation and that supports at least 75% cover of tidal marsh vegetation. Tidal flats are regularly inundated by the tides but lack 75% cover of marsh vegetation. The indicative species of the tidal marsh plain vary with salinity regime. Examine the

interior reaches of a nearby tidal marsh plain, equidistant from any tidal marsh channels or pannes, to identify the indicative species for any particular site,. Typical marsh plain flora for saline and brackish regimes include, but are not limited to, *Salicornia* spp (pickleweed), *Jaumea carnosa (*fleshy jaumea*)*, *Distichlis spicata* (salt grass), *Juncus balticus* (Baltic rush), *Triglochin maritimum* (seaside arrowgrass), and *Cotula coronopifolia* (brass buttons). In the case of tidal marsh restoration sites that do not yet support 75% cover of tidal marsh vegetation, the backshore is defined as the landward extent of the non-vegetated tidal flat.

3.1.1   Landscape/Watershed Scale Data
This section is not applicable.

3.1.2   Geomorphology
This section is not applicable.

3.1.3   Hydrology/Hydraulics
This section is not applicable.

3.1.4   Soil
This section is not applicable.

3.1.5   Sediment
This section is not applicable.

3.1.6   Water Quality
This section is not applicable.

3.2   Biological Characteristics

3.2.1   Field and Habitat Data
3.2.1.1 Vegetation
This section is not applicable.

3.2.1.2 Habitat Assessment
This section is not applicable.

3.2.1.3 Botanical Surveys

The Tidal Marsh-Upland Transition Zone Vegetation protoctol will be used to measure changes in the project restoration site over time. This protocol applies to the entire transition zone subject to the kind of vegetation management for which a measure of progress or performance is required. The attached protocol (Attachment A) describes the sampling approach and field data collection. This protocol was developed to meet the need for standardized data about the response of the transition zone plant community to onsite management activities. This protocol can also be used to in regional surveys of the ambient condition of the tidal marsh-upland transition zone.

In this protocol, plant community structure is assessed in terms of the vegetative cover (i.e., the percent of a specified area of land surface within the transition zone that is covered by each plant

species living in the zone), the maximum height of the species, and the relative abundance of non-native species. These data are particularly useful for characterizing the distribution of common species that make up the bulk of the biomass in the zone and less valuable for identifying rare species. These data can also help assess the value of the zone as wildlife habitat. Data on vegetative cover that are collected before and after restoration efforts can be used to assess their progress or performance.

Data on pounds of non-native plants removed through activities associated with this project are collected by field staff immediately following removal activities. Invasive plants are removed from site using either biodegradable bags or reusable woven plastic bags. Bags are weighed on site using a hanging scale. Pounds of invasive removed per program are recorded and input into our excel database.

3.2.1.4 Faunal Surveys
This section is not applicable.

3.2.2   Voucher Specimens for On/Off –Site Identification

Time permitting, unknown species encountered in the field will be taken to nursery on-site to be identified. One living specimen, including roots, and flowering head, will be preserved using a plant press and brought to nursery to be keyed. Pressed sample will be labeled with sampler name, date, project, site, and plot at which it was collected. Under time and/or resource constraints, unknown specimen will be labeled as such on field data sheet.

3.2.2.1 Botanical
NA

3.2.2.2 Faunal
This section is not applicable.

4.0   FIELD PREPARATION AND DOCUMENTATION

4.1   Field Preparation

Permits

Prior to conducting field protocols, all permits will be updated and resubmitted if expiration date has passed.

Review of Protocol

Prior to implementing monitoring, the proposed protocol will be reviewed. Equipment needs identified and coordinated for field use. If the protocol is further refined, all revisions will be documented.

Determine Sample Sites

A sample site is a continuous portion of the sample universe at least 25m long and having essentially the same height and width, or if the entire sample universe is 25m long or shorter, than the site and the sample universe are the same. A large project can have multiple sites that are separated by land covers that are not transition zones, and separate sites can have different

widths and heights. For example, one site might have natural topography and another site at the same project might consist of a levee.

Determine and Map Sample Size and Sample Plot Selection

Sample size is the number of plots per stratum at one site. The total number of plots per stratum should represent 10% of the stratum surface area. Each stratum at each site should have equal sample size, but the sample size can vary between sites.

Sample plots are randomly selected for each stratum at each site according to either of the two following procedures. One alternative uses high-resolution aerial imagery in a Geographic Information System (GIS). However, use of such technology requires access to it plus expertise that are not essential for this protocol. The field alternative can be used when a GIS is not available.

GIS

9. In a GIS, draw the boundaries of the four sample strata on recent-vintage 1-m pixel resolution or higher resolution digital aerial imagery (i.e., recent NAIP imagery or suitable site-specific imagery).

10. Overlay a 1.0-m^2 grid across the entire sample site.

11. Using the GIS, estimate the total area of each stratum in the sample site.

12. Determine how many 1.0m^2 cells equal 10% of the surface area of each stratum at the site. This is the sample size.

13. Assign a unique alpha-numeric code to each cell in the grid for each stratum. For each stratum, randomly select the number of cells equal to the sample size.

14. Mark the latitude and longitude of each selected cell on the grid and mark each selected cell on the imagery to produce a map of the sample plots.

15. The sample plots can be located in the field by inputting their unique latitude and longitude coordinates ass way-points into a Geographic Positioning System (GPS) with 1-m horizontal accuracy, or by using the sample plot map from step 6 immediately above.

4.2 Field Notes

4.2.1 Field logbooks

Field notes will be kept in a loose-leaf binder and will include comments form field staff and datasheets and forms.

4.2.2 Field Data Sheets and Forms

A standard datasheet is provided for all data collected in the field using this protocol. The data sheet should have, at a minimum, the following fields of information for each sample plot:

- Name of project
- Names of data collectors
- Date and time of day
- Name or code for sample site
- Stratum code
- Plot code
- Plot size (0.25 m^2)
- One field per each of the indicators as listed below
  - Percent bare ground
  - Percent thatch without vegetation
  - Percent cover by species
  - Maximum plant height by species
  - Percent cover of non-native species
  - Percent cover of native species
  - Total percent cover of all species
- Comments

4.2.3   Field Photographs

See Attachment B Oregon Watershed photo-point protocol

4.3   Documentation of Sample Collections
This section is not applicable.

4.4   Labeling of Sample Collections
This section is not applicable.

4.5   Field Variances
As condition in the field may vary, it may become necessary to implement minor modifications to sampling as presented in this plan. When appropriate and feasible, the EPA project officer will be notified before implementing changes. Minor or temporary modification should be documented in field logbooks or field data sheets in the final report as appropriate. Significant or major changes to the approved plan may require prior approval by the EPA Project Officer and will need to be documented in the final report. If the project is on-going the QAPP may need to be revised or amended.

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Saving Marshlands, The Bay, and Salmon-Maybe, Just Maybe, It's Going To Work

Written by Karen Nakamura
Wednesday, 31 March 2010

The Coastal Post is among those worried about the ability of migratory salmon to return to Northern California streams and for their offspring to find sufficient food sources to grow into healthy adults. With its extensive tributary system, the greater San Francisco Bay is especially important to the cycle of life of wildlife. For instance, the surviving number of clapper rail birds is said to be approximately 1,500. That's down from what was once estimated to run in the hundreds of thousands. The same is true with almost all wildlife.

A white egret that has just caught a vole takes flight over a recently flooded dairy field.
Photo by David Wimpfheimer, calnaturalist.com.

And, while the CP formerly emphasized the relationship between San Geronimo Creek Coho and feeding grounds such as the Bothin Marsh in Mill Valley. Chris Pincetich, the watershed biologist for SPAWN (Salmon Protection And Watershed Network) informs us that Marin's Coho don't actually go into the San Francisco Bay very often.

However and more importantly, what he did want understood was that every Chinook salmon that spawns in the creeks and tributaries throughout the San Francisco Bay and Sacramento/American River watersheds passes through the Bay.

Happily, on Feb. 10th the US Fish and Wildlife Service announced an ambitious 2010 National Coastal Wetlands Conservation Grant Program. Within it is a San Francisco Bay tidal marsh recovery plan designed to restore those oh-so important food-producing wetlands running around the entire shoreline including Marin and Sonoma County. Besides feeding massive numbers of any number of species, shoreline marshes filter pollution while protecting against flooding and erosion.

The effort this plan hopes to generate is said to be second only to the restoration project in the Florida Everglades and will encompass the entire American coast. Some projects are already active or at various stages of development. Readers would be well served to rummage around the U.S. Fish and Wildlife site for an encouraging and wider perspective.

While the West Coast focuses on Pacific salmon declines, Atlantic salmon are among the most endangered in the Northern Atlantic region. Migrating between Maine and Greenland, and only remnants remain of the once abundant salmon. Their comeback is a priority for Fish and Wildlife.

Saving the San Francisco bay system has been the goal of activists for over fifty years. Since then restoration pockets have popped up as volunteers and governments raised funds and planted cord grass and pickle-weed, essential to the re-establishment of life in the waters of the Bay. Through organizations such as Save the Bay, Fish and Game, the Marin County Department of Parks and Open Space and a huge number of volunteers spots of life are sprouting up from Redwood City to Petaluma and up the Delta to Sacramento.

Reportedly, of the original 190,000 acres of tidal feeding grounds in the San Francisco Bay, only 40,000 remain of which 24,000 were or are currently being restored. Besides Chinook passing through during their season, the San Pablo Bay National Wildlife Refuge along Highway 37 reports saltwater species seen "include flounder, striped bass, sturgeon and sharks." And there's milkfish and barracuda, mobi and shrimp. Stingrays are found off Paradise Drive near Highway 101. White herons dot its shore. All these species need a healthy feeding system to survive.

Importantly, the recovery plan will connect efforts across the board to create a cohesive, supportive whole. Until now restoration projects have been a patchwork of governmental and volunteer efforts. The plan, 15 years in the making, is one part of a series of efforts across the United States to restore wildlife habitat. Estimates are that it will take 50 years to complete. Now in its final planning stage, public comments will be accepted until March 10. After revisions, Fish and Game hopes to begin implementing the plan by the end of the year.

Nineteen million dollars in grants will be used to support 25 projects "benefiting fish and wildlife on more than 6,100 acres of coastal habitat in 11 states." These grants will be matched by nearly $26 million "in partner contributions from state and local governments, private landowners and conservation groups" and will be used to "acquire, restore or enhance coastal wetlands and adjacent uplands to provide long term conservation benefits..."

Lost in the shuffle and worrisome to fiscal hawks is the funding source. The program, under the 1990 Coastal Wetlands Planning Protection and Restoration Act, has funding provided by the Sport Fish Act and revenue generated by an excise tax on fishing equipment, motorboats and small engine fuels.

Other criticism points out that a lot of the targeted land belongs to local entities such as city and county governments or private investors. In a time of strapped budgets will local entities be able to come through? There's also a problem of access and easement rights and the serious gap in the structure in the south bay. Cargill has rights to mine its salt ponds "forever." That was the trade off for environmentalists to get the marshlands next to it. But that situation requires a separate investigation.

On March 27 between 9-12, Save the Bay is holding a "Restore the Bay Shoreline at Bothin Marsh in Mill Valley" workday where they will continue efforts at improving wetland habitat by removing non-native weeds. Go to savesfbay.org for more information.