Exhibit 2

San Francisco Estuary Invasive *Spartina* Project

California Clapper Rail Habitat Enhancement, Restoration and Monitoring Plan

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1 INTRODUCTION

1.1 Purpose of Document

This document describes a five year plan that will be implemented by the State Coastal Conservancy and others to provide enhanced habitat support for California clapper rail (*Rallus longirostris obsoletus*) in areas where non-native cordgrass (*Spartina* spp.) has been or is being eradicated. The plan has been prepared to comply with specific requirements of the U.S. Fish and Wildlife Service as described in the San Francisco Estuary Invasive *Spartina* Project Section 7 Biological Opinion (USFWS 2011) and in verbal and written comments on a previous draft restoration plan (Zaremba et al. August 2011; Hull, Raabe, Solvesky, pers. comm. September 15, 2011; Raabe memo November 28, 2011).

1.2 History and Effects of Non-native *Spartina* Invasion in the San Francisco Estuary

Smooth cordgrass (*Spartina alterniflora*), native to the Atlantic and Gulf coasts, was introduced to the east shore of San Francisco Bay by the U.S. Army Corps of Engineers in 1977 as part of a restoration experiment (Williams and Faber 2001). The introduced grass hybridized with native California cordgrass (*Spartina foliosa*), and within a few generations, a highly fertile and self-fertile “hybrid swarm” began spreading in the San Francisco Bay (Sloop *et al.* 2008, Ayres *et al*. 2008). This “swarm” quickly invaded and dominated every tidal marsh restoration project initiated in the central and south bay since the 1980s (**Figure 1**; 47 projects totaling 1,600 hectares; ISP 2007a, 2007b, Ayres and Strong 2004a, 2004b). Many of the hybrid plant forms (“morphotypes”) were much taller than either parent species, produced bigger flowers with more seed and pollen, and grew readily in areas where the native could not, forming dense, monotypic meadows. In addition to thwarting restoration efforts, the aggressive hybrids encroached on the bay’s mudflats (Ayres *et al.* 2003a, 2008), critical foraging habitat for local and migratory shorebirds and waterfowl (Goals Project 1999, SFBJV 2001, Stralberg 2010), and moved into low and mid-tidal marsh, displacing native cordgrass and other flora used by the federally endangered California clapper rail and salt marsh harvest mouse (*Reithrodontomys raviventris*). Researchers concluded that the pollen swamping effect of the hybrids combined with its displacement of native biota placed the native cordgrass in “immediate danger of extirpation” in the San Francisco Bay (Ayres *et al.* 2003b, 2004c).

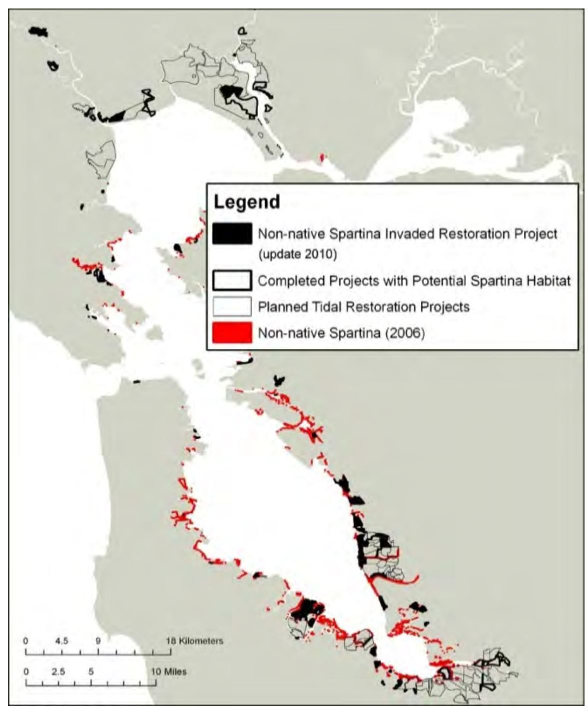


Figure 1. Map of Invasive *Spartina* distribution in 2006, invaded tidal marsh restoration sites as of 2010, and recent and planned restoration at risk of invasion.

Dense-flowered cordgrass (*S. densiflora*), native to South America, was introduced to the Corte Madera Creek watershed in Marin County in the 1970s, when it was mistaken for California cordgrass and planted in a restoration project. By 2005, dense-flowered cordgrass dominated local tidal marsh restoration projects, and had spread throughout the entire tidal reach of Corte Madera Creek. Dense-flowered cordgrass then moved rapidly into tidal marsh preserves along the Marin shoreline, and spread from this location to other areas in San Pablo Bay and further south into Central and South San Francisco Bay.

English cordgrass (*S. anglica*), itself a hybrid between smooth cordgrass and small cordgrass (*S. maritima*, a native of southern Europe and western Africa), was also introduced to the Corte Madera Creek watershed as part of the project that brought in dense-flowered cordgrass (Williams and Faber 2001). English cordgrass spread moderately through the Corte Madera Creek watershed, but seemingly not significantly outside of that area. It has been controlled along with the hybrid *S. alterniflora* x *foliosa* and dense-flowered cordgrass, and hasn't posed a significant problem in its own right.

The introduction history of salt meadow cordgrass (*S. patens*), native to the Atlantic and Gulf coasts, in San Francisco Estuary is unclear. So far it occurs in only one geographic region, at Southampton Marsh in Suisun Bay, which may be the southern extent of its potential range. At this location, it appears to serve as a nominal host to the endangered hemiparasitic soft bird's-beak (*Cordylanthus mollis* ssp. *mollis*), but it also spread and may have eventually displaced the soft bird's beak without control. Salt meadow cordgrass has been found to be extremely invasive in many other regions and could be an additional significant threat baywide, should it begin to migrate south of its current location.

1.3 Control of the Non-native *Spartina* Invasion in the San Francisco Estuary

In order to protect the native tidal marsh ecosystem and the major restoration projects that were underway throughout the Estuary, the State Coastal Conservancy and the U.S. Fish and Wildlife Service initiated the Invasive *Spartina* Project (ISP) in 2000. Over the next few years, the project evaluated treatment approaches, developed necessary partnerships, and completed an exhaustive inventory of the bay-wide distribution of non-native *Spartina*. From 2000-2003, the State Coastal Conservancy and U.S. Fish and Wildlife Service conducted initial environmental planning and permitting work, resulting in the Final EIR/EIS being issued in September 2003. The Federal Record of Decision was completed in September 2004, and a pilot year of treatment using Glyphosate herbicide was conducted at 12 sites during the limited treatment window from September to October 2004.

In November 2004, the Conservancy hosted the Third International Conference on Invasive *Spartina*, with an invited panel of experts from California, Washington, France, China, Tasmania, New Zealand, and the United Kingdom, all of whom had been researching or battling invasive *Spartina* species for decades. Asked whether and how the ISP should attempt to control the (predominantly hybrid) *Spartina* invasion, the panel noted that the San Francisco Bay *Spartina* invasion was young by invasion standards, and there was therefore a good chance it could be eradicated with an aggressive and coordinated effort (Ayres 2010). Encouraged by the panel's recommendation, and because of the agreed importance of preserving the native ecosystem, the Invasive *Spartina* Project was fully funded by both the State and Federal agencies. An improved approach to treatment that included the application of Imazapyr herbicide via ground and aerial applications was developed in 2005, and by July 2006, an effective, coordinated, region-wide eradication effort was underway.

By the time full-scale control was initiated in 2006, the net area of invasive *Spartina* was greater than 800 net acres, distributed over many thousands of marsh acres throughout much of the Estuary. By the start of the treatment season in 2010, four years later, the program had reduced the bay-wide population by 90%, to less than 100 net acres. At the end of 2010, ISP managers projected that, with continued control, up to 90% of the remaining 170 sites would have 'zero detect' (where no discernible non-native *Spartina* is found during yearly inventory monitoring) by 2013.

In 2011, however, USFWS became concerned regarding reduction in California clapper rail numbers at many *Spartina* treatment sites, and declined to authorize treatment at 25 sub-areas where clapper rail are present. Treatment of more than 75 other sub-areas was delayed several months pending review of the project and completion of a new Section 7 Biological Opinion, which was issued on September 23, 2011. Treatment of most authorized marshes was completed between October 1 and November 20; however, with the lack of treatment at many areas, and unknown prospectus for future treatment authorizations, the projected timeline for eradication has been extended by a minimum of three years.

1.4 Ecosystem Response to Removal of Invasive *Spartina*

Marsh restoration efforts in the San Francisco Bay have primarily relied on passive revegetation. Earlier research in the Bay noted that tidal marshes will become naturally revegetated if the appropriate hydrological conditions are present and marshes are connected hydrologically to other nearby marshes (Williams and Faber 2001). Bi-annual photo point monitoring as well as observations by biologists have shown that native plants rapidly colonize areas where non-native *Spartina* has been sufficiently removed (2006 to present at 70 treatment sites; Google Maps link: http://g.co/maps/xj67d). Many areas have undergone rapid and large-scale passive restoration that includes a return to predominantly native plant assemblages (at low and mid-marsh elevations), or to mudflat and tidal channel conditions (at lower elevations). As the marshes recover from the *Spartina* invasion and removal, it is anticipated that vegetative complexity and plant densities similar to pre-invasion will occur passively in most marshes. However, in some areas near points of initial introduction and in areas where hybrids were intentionally introduced through transplanting, hybrid *Spartina* (and in one case, *S. densiflora*) effectively displaced much of the native flora and significantly changed the marsh structure (**Figure 2**). Some of these areas are not expected to revegetate passively within 5-10 years, particularly areas where *S. foliosa* has been extirpated.

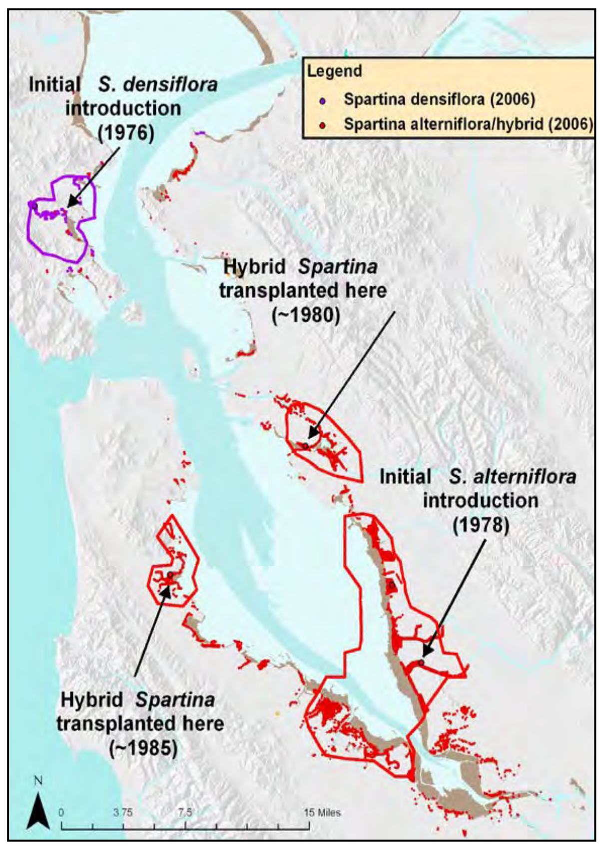


Figure 2. Regions of San Francisco Bay that were highly impacted by non-native *Spartina* invasion and subsequent removal surround the points of initial introduction and early transplanting.

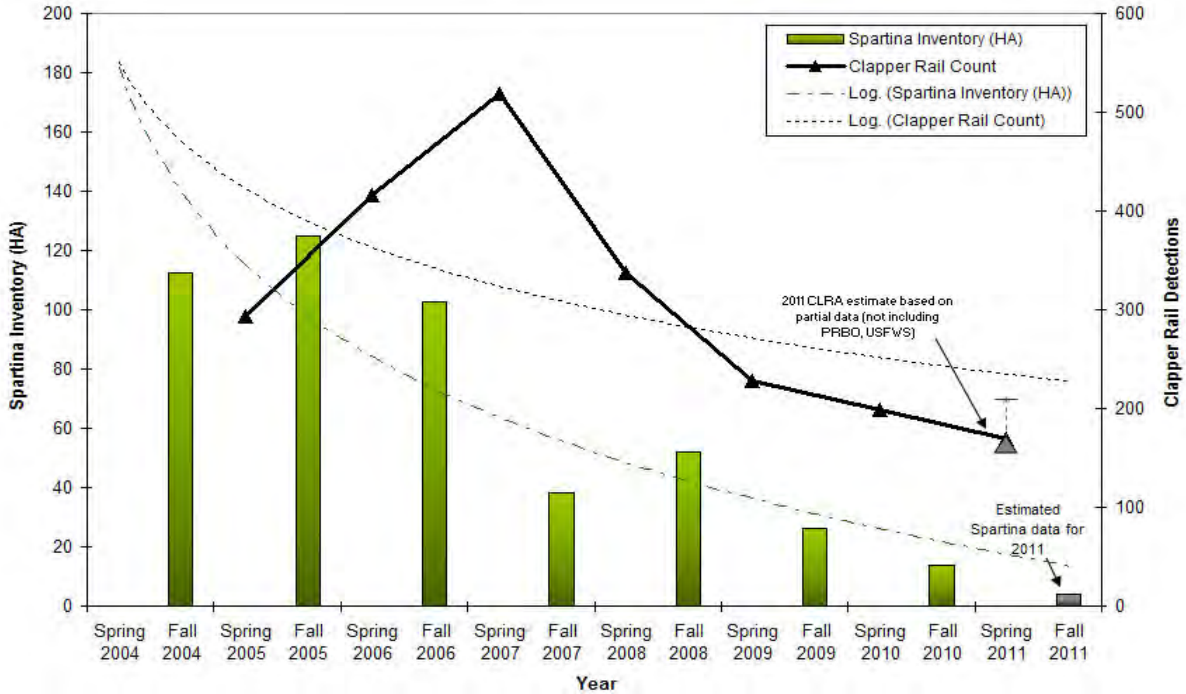


Figure 3. Annual California clapper rail survey results and net area of non-native *Spartina* in the San Francisco Estuary from 2004 to 2011. Data are combined from ISP, USFWS, and PRBO sources for 30 subsites within four clapper rail regions (as defined by USFWS). 2011 data is draft and includes ISP only; USFWS and PRBO data will be added when available.

1.5 Effects of Invasive *Spartina* and Its Control on California Clapper Rail Populations

The endangered California clapper rail is an obligate tidal marsh bird found primarily within the San Francisco Bay Estuary. Clapper rail numbers increased from 1,040–1,264 in 1992-1998 (Albertson and Evens, 2000) to 1,425 (±22) in 2005-2008 (Liu *et al.*, 2009). The increase in clapper rail numbers occurred at a time when a hybridized, invasive *Spartina* spread rapidly throughout the Bay. Hybrid *Spartina* likely affected clapper rail numbers positively for two reasons: tall, dense hybrid *Spartina* provided increased cover for clapper rails reducing exposure to predators and tides; and hybrid *Spartina* converted mudflat to marsh habitat, allowing clapper rail populations to grow and expand into new areas.

Since 2006, there has been nearly a tenfold reduction in hybrid *Spartina* (Hogle, 2011) due to effective control by the Invasive *Spartina* Project. This reduction in hybrid *Spartina* has been accompanied by declines in California clapper rail populations, particularly in the Central and Southern San Francisco Bay (**Figure 3**). While conditions vary between sites, review of the relation between hybrid *Spartina* cover and California clapper rail numbers suggests that the two are highly correlated during the expansion of the plant into native marshes and mudflats, and during the first several years of *Spartina* removal, with the reduction of clapper rail numbers lagging behind *Spartina* reduction by 1½ - 2 years. At sites where removal of *Spartina* resulted predominantly in return to mudflats or very early tidal marsh restoration stages, clapper rail numbers continued to decline, at some sites to zero. At sites where native marsh vegetation was present after *Spartina* eradication, clapper rail numbers generally appeared to have stabilized at some level significantly below the peak population numbers that occurred around 2006. At some sites very slight increases in clapper rail numbers were seen in 2010 and 2011.

It is the substantial decline of California clapper rail numbers between 2007 and 2009 (which resulted from *Spartina* control executed between 2005 and 2007) that has triggered concern for the status of the endangered species and resulted in the need for rapid and aggressive actions to replace habitat functions lost by the eradication of invasive *Spartina*. Because invasive *Spartina* has been nearly eradicated, the ISP does not expect that the continued removal of the remaining small areas of *Spartina* will result in any additional decline of clapper rail numbers at most sites[1].

1.6 Habitat Requirements of California Clapper Rail

The resilience of clapper rail populations depends upon large contiguous high-quality tidal marsh habitat, with extensive channel systems, cover for foraging, and high-tide refugia (USFWS, 2010). Marsh size, location relative to other marshes, presence of transitional zones between marshes and upland areas, marsh elevation, and hydrology are all identified as important characteristics of clapper rail habitat in San Francisco Bay. Within the tidal marsh ecosystem, specific microhabitat zones provide key functions to clapper rail ecology. The Draft Recovery Plan describes these microhabitats as including the following:

Channels: California clapper rail rely on tidal channels as movement corridors through the marsh plain, as well as foraging substrates. Vegetative cover along channels is provided by both marsh gumplant (*G. stricta*) along the upper bank and native *S. foliosa* along the lower bank. Nests are frequently located near channels, as well-concealed channels offer a rapid escape route from predators.

Low Marsh Zone: In a native marsh, bands of *S. foliosa* form along the bayfront and channel edges. Native cordgrass is an important component of clapper rail habitat, providing cover during foraging. Additionally, the corridor of fringing *S. foliosa* provides connectivity between marshes and complexes, reducing the isolation and promoting the long-term sustainability of clapper rail populations. The fringing band of *S. foliosa* may also help reduce wave action and prevent the loss of the marsh habitat from erosion.

High Marsh Zone: The upper elevation zones within the tidal marsh system provide important high-tide refugia and nesting substrate for California clapper rail. At high density clapper rail sites, the high marsh is often dominated by *G. stricta*, which provides vegetative height and cover above high tides (**Figure 4**). Clapper rail often nest in *G. stricta* when dense enough stands are present. Additionally, the skeletons of dead *G. stricta* act as a trellis for low growing marsh plants to weave through, creating additional height in the high marsh zone.

Marsh-Upland Transition Zone: The transition zone provides a buffer between the marsh and adjacent upland habitat. This microhabitat acts as a barrier to some terrestrial predators, including humans and their companion animals. Additionally, a native transition zone may offer cover and protection from predators during extreme high-tide events. These events occur infrequently and mostly in winter, but may account for the bulk of clapper rail mortality (C. Overton, pers.

[1] There are a few exceptions to this, including Arrowhead and MLK Marsh, and parts of Seal Slough, Robert's Landing, and Cogswell marshes. These areas were not treated in 2011, and ISP expects that clapper rail populations will have again elevated in response to hybrid *Spartina* cover, so that when treatment is reinitiated populations will again decline.

comm.). This zone historically included the greatest species richness of native marsh plants, but biodiversity has been substantially reduced by marsh habitat alteration at most tidal wetland sites in San Francisco Bay. Remaining marsh-upland transition zones are narrowed and steepened due to development at the periphery of marsh sites, and heavily impacted by invasive species at most sites. This zone will become increasingly important in the face of sea-level rise, as it can accrete sediment, slow over land flow of water, and provide a refuge for rails and other marsh species during extreme high tide events. Extreme high tide events, or "king tides", occur a couple times a year for a few hours on a few days in winter and summer. Extreme high tide refugia benefits clapper rail during such tides, but the potential effect is temporally limited.

Figure 4. Herbicide applicator accompanied by a trained clapper rail biologist for "spot cleanup" of remnant hybrid *Spartina* patches in high quality California clapper rail habitat (Greco Island, Don Edwards National Wildlife Refuge, Redwood City). Note dense cover of *Grindelia stricta* in the high marsh zone, adjacent to open channels for foraging.

2 CALIFORNIA CLAPPER RAIL HABITAT ENHANCEMENT AND RESTORATION PROGRAM

2.1 Program Goals

The goal of this program is to rapidly establish habitat features to benefit California clapper rails at strategic locations near where recent removal of non-native *Spartina* has caused decreases in local California clapper rail populations. This work will also begin to reintroduce native *S. foliosa* into regions where it has been extirpated or radically reduced by the spread and eradication of hybrid *S. alterniflora x foliosa*, providing the foundation for future restoration of diverse native tidal marsh habitat in these areas.

2.2 Program Objectives

The objectives to achieve the program goals are as follows:

1. Deploy artificial floating islands at strategic locations at or near invasive *Spartina* eradication sites to provide near-term habitat cover for California clapper rails, including refuge habitat during December and January winter high tide events, and potentially nesting habitat from February 1 through August 30.
2. Evaluate opportunities for, and implement as feasible, near-term construction of appropriate marsh elevations for high-tide flood refugia and other habitat features to benefit California clapper rails in existing tidal marshes and restoration projects at or near invasive *Spartina* eradication sites. Also investigate opportunities for modifying hydrologic regimes in diked marshes to enhance California clapper rail habitat; for example, by increasing flow in marshes that lack sufficient tidal inundation (e.g., East Marsh in San Leandro and Pond B3 in Hayward), or by decreasing (damping) flow in marshes where high tides are otherwise too high to allow adequate refugia for clapper rails (as occurs at La Riviere Marsh in Fremont).
3. Coordinate or assist predator control actions in locations where predation by land mammals has a potentially significant impact on California clapper rail populations.
4. Initiate intensive planting of *G. stricta*, *S. foliosa* and other native vegetation in strategic locations at or near invasive *Spartina* eradication sites, in an effort to rapidly establish enhanced cover, nesting and high tide refugia habitat for California clapper rails.
5. Continue and complete Bay wide eradication of invasive *Spartina* to minimize short and long term adverse effects for California clapper rails and to protect the native ecosystem.

Specific details, including numeric criteria and timelines, are provided in the project description below.

2.3 Program Structure and Scope

Implementation of the program will be coordinated and overseen directly by the State Coastal Conservancy with assistance from the ISP, and work will be implemented through contracts for planning and implementation. USGS will be the lead for planning, deploying, and monitoring floating islands (Objective 1). An environmental consulting firm (H. T. Harvey and Associates) has been retained to evaluate opportunities for construction of marsh elevations suitable for high tide refugia, and modification of hydrology to improve clapper rail habitat features (Objective 2). Conservancy will work with USFWS Refuge, U.S. Department of Agriculture and others to implement predator control at selected sites (Objective 3). The primary ISP consultant (Olofson Environmental, Inc.) will play a lead role in planning and monitoring planting of native vegetation, as the ISP continues with treatment efforts to eradicate invasive *Spartina* (Objectives 4 and 5).

2.4 Program Approach

The Conservancy and US Fish and Wildlife Service have worked together to develop the following strategies for achieving the program objectives (Section 2.2).

2.4.1 Deployment of Floating Islands to Provide Clapper Rail Refuge and Nesting Habitat

Artificial floating islands may provide interim high-tide refugia during the transition from non-native *Spartina* habitat to a native and diverse marsh plain. Floating islands are used successfully by light-footed clapper rail (*Rallus longirostris levipes*) in southern California for nesting (e.g., Zembal 2010). However, artificial habitat may pose risks such as functioning as an advertisement to predators of the presence of hiding prey. Floating islands have not been tested extensively in San Francisco Bay and more study is needed to assess the benefits to and potential effects on California clapper rail populations before they are deployed at a large scale in Bay marshes.

Pilot work investigating clapper rail use of artificial floating islands was initiated in 2010 by the USGS Western Ecological Research Center (**Figure 5**). In 2010, USGS deployed 10 artificial floating "habitat" islands at Arrowhead Marsh to serve as high tide refugia during winter high tides. Initial use of the islands by roosting clapper rails was high, with documented presence of clapper rails within three days of deployment. It remains unknown whether the observed use of the artificial islands by clapper rails has resulted in higher population growth rates, and small sample size makes it unlikely that a single season will be sufficient to detect differences in survival rates due to the addition of artificial islands. Artificial islands may also increase clapper rail reproductive rates, and one artificial "habitat" island designed for high tide refuge was used as nesting substrate by a pair of clapper rails that successfully hatched a nest in late May of 2011.

The Conservancy and the ISP will coordinate with USGS to continue studies on rail use of floating islands and to determine the best strategy to employ floating islands as interim high-tide refugia during *Spartina* control. In 2011-12, USGS will build on existing studies using artificial islands by installing 10 "habitat" islands for a second year at Arrowhead Marsh, and by incorporating smaller floating "nesting" islands at 25 locations within each of 5 marshes in South San Francisco Bay.

The criteria for selecting sites for both types of floating islands include:

- Sites with clapper rails
- Sites still undergoing invasive *Spartina* treatment
- Sites lacking in native vegetation that provides high tide flood refugia

2011-12 floating island sites include:

- Arrowhead Marsh in Oakland (East Bay Regional Park District)
- Greco Island in Redwood City (Don Edwards National Wildlife Refuge)
- Robert's Landing Complex including North, Citation, and Bunker Marshes and the San Lorenzo Creek Mouth (City of San Leandro)

- Cogswell Marsh in Hayward (East Bay Regional Park District)
- Whale’s Tail North Marsh in Union City (CA Department of Fish and Game)

The first two sites will be funded by USFWS, and the last three will be funded by the State Coastal Conservancy. Large floating islands (5’ X 7’) used at Arrowhead Marsh are impractical for use at these marshes due to a lack of suitable open bay edge adjacent to occupied habitat. The smaller nesting island design (20” X 28”) will facilitate more efficient use of refuge and is expected to provide better nesting substrate for California clapper rails. Islands will be constructed in a similar manner as the larger refuge islands with a frame supporting artificial cover made from commercially available woven palm leaf blind material. Five additional islands will be used to test whether native plants will grow that can be used as additional cover on the islands.

Ultimately, island placement will be contingent on extant vegetation conditions, but the criteria for selecting locations will also be focused on equal representation of in-channel locations, channel edge locations, and marsh plain locations. In addition, USGS will space islands more than 50m from each other to maximize the number of potential clapper rail territories that have supplemental refuge. Island use by clapper rail will be monitored using time lapse cameras. All of these data will help to inform the future best approach to the utilization of floating islands for the short-term enhancement of habitat for CA clapper rails.

Figure 5. Example of floating island installed by USGS researchers in 2010 to provide high tide refuge for California clapper rails at Arrowhead Marsh, Oakland.

Autonomous recording units (ARUs) will be deployed to a subset of floating islands in order to improve presence/absence surveys for rails, model occupancy, detect presence in hard to access marshes, and document colonization of new march restoration sites. In 2011 up to 25 ARUs will be mounted to artificial islands at Arrowhead Marsh. These units will be deployed throughout the breeding season and will provide data addressing several management questions. By recording clapper rail call activity throughout the day and throughout the season it will be possible to identify periods of peak call activity both within the course of the day as well as across the breeding season. This data can then be correlated with weather to help understand the interaction between weather and clapper rail calling activity. Together these data may be applied to current call count surveys that take place throughout the year in a variety of weather conditions and allow for better interpretation of call count data.

The 2011 ARU data will also be used to create optimized clapper rail call detectors in the Raven software package and allow USFWS to determine the best deployment strategy for future monitoring at other sites (time of day when recordings should be focused, spacing of units in marshes, etc.). Using this information it will be possible to design and implement a monitoring strategy for marshes throughout the bay where it is difficult to access the site for surveys (e.g., parts of Greco Island) as well as at sites where vegetation restoration efforts have been focused in order to document success (colonization and use) of restored marsh habitat.

2.4.2 Construction of High Marsh Elevations, Modification of Hydrologic Regime, or other Engineered Solutions to Reduce Effects of Extreme Winter Tides and Storms and Enhance Tidal Marsh Function for California Clapper Rails

While enhancement of revegetation in existing marshes will provide additional habitat, creating new marsh habitat is also critical to the recovery of the species. The Conservancy is working with H.T. Harvey and Associates to conduct additional restoration planning to benefit California clapper rails. H.T. Harvey will primarily assess feasible opportunities for the construction of high tide flood refugia elevations at both treatment and non-treatment sites baywide. They will identify and prioritize sites that will both provide a real benefit to existing clapper rail populations, and are feasible and cost-effective to restore. In addition, H.T. Harvey will also investigate opportunities for modifying hydrologic regimes in diked marshes to enhance California clapper rail habitat; for example, by increasing flow in marshes that lack sufficient tidal inundation (e.g., East Marsh in San Leandro and Pond B3 in Hayward), or by decreasing (damping) flow in marshes where high tides are otherwise too high to allow adequate refugia for clapper rails (as occurs at La Riviere Marsh in Fremont).

This tiered assessment will involve screening potential sites beginning with GIS and aerial photography map review, and ending with reconnaissance level field surveys of the sites with the highest restoration potential. Site selection criteria will include:

- Existing ISP partnerships that would readily allow use for the site for restoration
- Site supports ongoing restoration efforts
- Site is within or adjacent to existing ISP treatment site
- Site was historically used by clapper rails and experienced loss of habitat cover due to treatment of invasive *Spartina*
- Existing clapper rail population present or adjacent to potential high tide flood refugial restoration site to facilitate colonization

- Existing high tide flood refugia (or suitable breeding) habitat is absent or likely limiting clapper rail abundance
- Relative feasibility and likely cost of high tide flood refugial habitat restoration
- Site may be especially vulnerable to sea level rise

In addition, the Conservancy is an active partner in multiple large-scale tidal marsh restoration efforts, including the South Bay Salt Pond Restoration Project, Hamilton Wetlands Restoration Project, Napa-Sonoma Marshes Restoration Project, Breuner Marsh Restoration Project and others. Providing additional tidal marsh habitat through these large-scale restoration projects is the key to clapper rail recovery, but the restoration process takes time and many of these sites do not yet have appropriate marsh elevations and vegetation to support California clapper rails. These long-term restoration projects will ultimately provide thousands of acres of tidal marsh designed to provide habitat for California clapper rail and other wildlife. The Coastal Conservancy will work with partner agencies to ensure that planning and design of future projects will incorporate appropriate high tide refugia habitat for clapper rail.

Phase I of the South Bay Salt Pond Project is nearing completion and included the breaching of salt ponds to ultimately create tidal marsh habitat. Phase I construction at the Eden Landing Ecological Reserve included re-grading multiple levees to a slope of 10:1 and at a height of 6.5 NAVD so that they could provide future high tide refugia once revegetated with appropriate marsh-upland transition zone species. Save The Bay has an active program of revegetation at Eden Landing that is designed to provide and enhance high tide refugia, and the Conservancy will fund Save The Bay to continue and expand this work here and at other sites around the Bay. Designing high tide refugia for clapper rail and other wildlife will be an integral part of Phase II South Bay Salt Pond planning.

Figure 6. California clapper rail under mixed cover in mid-marsh zone. Photo Bob Birkland.

2.4.3 Predator Control

Predators are a significant threat to most California clapper rail populations in the Estuary. Ongoing management of predator populations is already occurring and is needed in order to reduce mortality of clapper rails. The Conservancy and USFWS Don Edwards San Francisco Bay National Wildlife Refuge staff will work collaboratively to identify whether any changes to approach or additional funding would result in improvements to existing programs.

2.4.4 Revegetation of Habitat

The Invasive Spartina Project and its partners have been implementing relatively small revegetation projects to enhance California clapper rail habitat since 2005. This work has focused primarily on planting *Grindelia* and marsh-upland transition species at 6-8 sites in the east and west Bay (see examples in **Appendix 1**). Experiments in reestablishing *Spartina foliosa* in areas where it had been extirpated by the hybrid were begun only in 2011, because of high risk of pollination by hybrids and difficulty discerning natives from hybrids in a planted marsh.

This effort will now be stepped up considerably to accelerate revegetation and provide support for California clapper rails. Conservancy will lead planning and implementation of the intensive tidal marsh revegetation and monitoring program described in sections 3 and 4 below. In the first year (2011-2012) this program will result in planting of roughly 70,000 seedlings: 19,000 *S. foliosa*, 16,000 *G. stricta*, 5,000 assorted other marsh species at 25 marsh sites, and 30,000 seedlings to be propagated and planted by Save The Bay (*G. stricta* and other native marsh-upland transition zone species). In the subsequent 2012-13 restoration year, efforts will be expanded to include additional locations, and additional plantings per year. As described below, this work will be carefully targeted to rapidly create nesting and high tide refugia habitat for populations of California clapper rails.

2.4.5 Continued Control of Non-native Spartina

The ISP will continue to monitor and control non-native *Spartina* at all permitted sites throughout the Estuary, with the ultimate goal of eradicating all discernible non-native and hybrid *Spartina* within a foreseeable horizon. In 2011, there was less than 50 acres of non-native *Spartina* remaining within 40,000 acres of tidal marsh in the San Francisco Estuary. Continued control of non-native *Spartina* is necessary for the ultimate goal of a healthy and sustainable tidal marsh ecosystem (Goals Project 1999; USFWS 2010). Management of non-native *Spartina* is also critical if current efforts to enhance clapper rail habitat using native vegetation are to succeed, as hybrid *Spartina* would rapidly overrun and exclude any native plantings if not controlled, and native plants would be damaged or killed by efforts to control invasive *Spartina* were it to become reestablished.

Further declines in California clapper rail populations can be avoided at most sites still being treated, since most of the hybrid *Spartina* has already been removed and is no longer present in dense enough patches to provide cover. At sites where non-native *Spartina* still provides substantial clapper rail habitat, such as Arrowhead Marsh and MLK New Marsh in the San Leandro Bay, ISP will work with USFWS and other experts to develop and implement strategies to minimize additional declines in local populations.

3 REVEGETATION PLAN

A systematic approach was used to select invasive *Spartina* treatment sites at which revegetation would be (1) useful for enhancing clapper rail nesting and high tide refugia habitat, and (2) potentially successful, based on site conditions. The approach entailed identifying sites that had clapper rails present or populations nearby, and that could be planted with native vegetation to enhance habitat specifically for clapper rail. A set of criteria were established by which sites could be selected and then ranked for priority.

3.1 Selection of Revegetation Sites

The ISP identified 43 invasive *Spartina* treatment sites where revegetation could benefit California clapper rail through enhancement of nesting and high tide refugia habitat (**Table 1 and Figure 7**). The following criteria were used to select the sites for revegetation:

- Potential to provide additional, or enhance existing, clapper rail nesting and/or high tide refugia habitat in the near term
- Potential to achieve native marsh complexity and function associated with California clapper rail
- Sufficient size of marsh/marsh complex that could support large, resilient populations of California clapper rail
- Proximal to other marshes or marsh complexes to provide connectivity for California clapper rail dispersal
- Potential to serve as a source of seed for adjacent marshes
- Lack of potential for key plant species (i.e., *G. stricta* and *S. foliosa*) to establish passively at the site in the near term
- Sufficient distance from non-native *Spartina* that could pollinate planted *S. foliosa* and produce hybrid seed

Given the need to achieve habitat enhancement quickly, and because plant material was limited in the first year, planting will be focused on a subset of sites originally planned for the 2011/2012 planting season. Most of the sites were selected primarily because there were existing clapper rail populations that would benefit in the near term from habitat enhancement. Additional sites were selected based on the presence of restoration work already underway by project partners, and in one case, on the opportunity to develop field-based propagation techniques and establish propagule sources that will be needed in subsequent years.

3.1.1 Considerations for Sea Level Rise

Anthropogenic climate change is predicted to modify precipitation rates, alter estuary salinities, increase sea level, and amplify the frequency of extreme weather events in intertidal zones (Nuttle, Brinson et al. 1997). Some researchers suggest that tidal wetlands in the San Francisco Estuary could be resilient to sea level rise over the next century as long as sediment supply remains adequate (Williams and Orr 2002). However, many researchers predict that vegetative communities will be altered (Callaway, Parker et al. 2007; Erwin 2009; Watson and Byrne 2009). The extent of change in the salt marsh community varies in different regions of the bay and with different climate change predictions (Watson and Byrne 2009).

Table 1: Current and Future Revegetation Sites (work to be conducted by Conservancy contractors or grantees unless otherwise indicated).

2011/2012 Sites (n=23)	Future Sites (2013 – 2016) (n=20)
Alameda Flood Control Channel Mouth, Lower/ Upper (01a, b, & c)	Alameda Flood Control Channel - Pond 3 (1f)
Arrowhead Marsh (17c) [1]	Belmont Slough Mouth (2a)[4]
Bair Island – B2 North (02c)	Cogswell - Quad B (20n) [4]
Bothin (23j)[1]	Colma Complex - Confluence Marsh (18f)
Cogswell - Quad A (20m)	Colma Complex - Navigable Slough (18b)
Cogswell - Quad C (20o)	Colma Complex - San Bruno Marsh (18g)
Colma Complex - Colma Creek (18a)[3]	Eden Landing - Cargill Mitigation Marsh (13f)
Creekside Park (4g)[2]	Fan Marsh (17j)
Damon Marsh (17d) [1]	Ideal Marsh South (21b)
Eden Landing – Eden Creek Marsh (13l)[1]	Old Alameda Creek - North and South Bank (13a,c)
Eden Landing – Mt. Eden Creek (13j)	Robert's Landing - Bunker Marsh (20g) [4]
Eden Landing – North Cr. Marsh (13k)	Robert's Landing - Citation Marsh (20d) [4]
Eden Landing - Whale's Tail North (13d)	Robert's Landing - Dogbone Marsh (20c) [4]
Eden Landing - Whale's Tail South (13e)	Robert's Landing – East Marsh (20e) [4]
Elsie Roemer (17a)[3]	Robert's Landing - North Marsh (20f) [4]
Faber/Laumeister (15b) [1]	Robert's Landing - San Lorenzo Creek Mouth (20h)
Greco Island North (2f)	Seal Slough Mouth (19p) [4]
MLK Restoration Marsh (17h)[1]	Ravenswood Slough (02i)
Old Alameda Creek - Island (13b)	Bair Island – B2 South (02d)
Oro Loma West (7a)	
Oro Loma East (7b)	
Palo Alto Baylands1 (08)	
Ravenswood Open Space Preserve – SF2 (02j)	

Notes:

1. Revegetation to be conducted by Save The Bay
2. Revegetation to be conducted by Friends of Corte Madera Creek Watershed
3. Revegetation to be conducted by Romberg Tiburon Center and ISP
4. Revegetation pending approval for *Spartina* treatment at the site

3.1.2 Considerations for Sea Level Rise

Anthropogenic climate change is predicted to modify precipitation rates, alter estuary salinities, increase sea level, and amplify the frequency of extreme weather events in intertidal zones (Nuttle, Brinson et al. 1997). Some researchers suggest that tidal wetlands in the San Francisco Estuary could be resilient to sea level rise over the next century as long as sediment supply remains adequate (Williams and Orr 2002). However, many researchers predict that vegetative communities will be altered (Callaway, Parker et al. 2007; Erwin 2009; Watson and Byrne 2009). The extent of change in the salt marsh community varies in different regions of the bay and with different climate change predictions (Watson and Byrne 2009).

Regional planning groups (Association of Bay Area Governments and Bay Planning Coalition) are working with regulatory agencies (San Francisco Bay Area Conservation and Development Commission, San Francisco Bay Regional Water Quality Control Board, U.S. Army Corps of

Figure 7. Location of California Clapper Rail Habitat Enhancement, Restoration, and Monitoring Plan Revegetation Sites (prepared 12/14/11)

Engineers), resource agencies (U.S. Fish and Wildlife Service, State Coastal Conservancy, and State Department of Fish and Game), and Bay Area flood control, wastewater treatment, and transportation agencies to assess the effects of sea level rise and develop a coordinated plan for the San Francisco Bay Area. Decisions from these multi-agency regional planning efforts will dictate the potential for long-term survival of a viable tidal wetland ecosystem. The ISP restoration plan can do little to influence or predict the outcome of regional planning for sea level rise in this highly urbanized area. However, some local ecologists suggest that a healthy native-dominated tidal marsh system will have a better chance of adapting to sea-level rise and continuing to provide support for a wide range of invertebrate, fish, bird, and mammalian species (Baye, pers. comm.).

Strategies to optimize marsh performance during sea level rise include targeting sites that are large and have the potential to naturally accrete sediment with increasing tide elevation. Also sites can be targeted that have adjacent high marsh and undeveloped upland to allow the marsh to migrate up into these areas, rather than be hemmed in by steep levees or sea walls. Planting design can emphasize establishment of suitable transition species in the marsh plain and transition zone to allow expansion landward as sea level increases. To increase areas for marsh expansion within the same site footprint, existing sub-tidal or low marsh areas could be filled to create mid marsh plains or high marsh islands. While this has a potential mid-term benefit for certain marsh species, it is probably not a long-term solution, and it may have short-term adverse impacts on species that require sub-tidal and low marsh.

3.1.3 Reference Sites

Reference sites are used in restoration to provide models for comparison that can be used to assess performance for various aspects of a project ranging from simple presence/absence of features or species to the performance of complex ecological functions. It is often difficult to find suitable reference sites because of the absence of "pristine" areas, especially around major urban centers. Virtually all areas have been impacted by human development, and each type of impact presents new variables to reconcile. Ideally, the goal would be to work towards features and functions similar to those of high quality natural marshes; however, many marshes around the Bay lack the fundamental structure (continuous elevational gradient from subtidal to upland, large size, channelization, location that is safe from domestic pets and other predators) that will make this possible. This program must assess progress in the near term, when marshes are much younger and less developed than mature marshes, even though marsh complexity and function will take decades if not centuries to develop. Thus, it is necessary to include examples of functional-but-not-ideal habitat for reference. A final, very significant consideration for this program is that the primary goal is to rapidly establish habitat features that will benefit California clapper rail. Therefore, evaluation of habitat enhancement in the near term will look to reference sites that support populations of clapper rail, with constraints similar to those that exist at the planned revegetation sites.

The Restoration Program has developed a list of potential reference sites (**Table 2**), some of which are recognized as mature and relatively pristine tidal marsh, and some of which simply represent good "normal" tidal marsh habitat types (e.g., non-invaded breached-levee tidal marsh restoration). Most of the reference sites have populations of California clapper rail, and are similar to sites planned for revegetation. The ISP may collect data from the reference sites to answer specific questions, but typically the program will consider existing data and reports.

3.2 Planting Plan

Given the program goals and objectives, an active planting plan was developed to provide rapid enhancement of nesting and high tide refugia habitat for California clapper rail at sites where invasive *Spartina* has been removed. Development of the plan has been informed by expert opinion from a Technical Advisory Committee and workgroups[2], and other regional clapper rail and tidal marsh restoration ecologists. The plan is to focus on high density revegetation plantings at sites where there are existing populations of clapper rail and where there is potential to sustain or support increased rail populations. Planning will focus on enhancement of the microhabitat zones described in Section 1.6. The primary species being planted include *G. stricta*, *S. foliosa* and appropriate transition zone plant species possibly including *Artemisia californica, Baccharis douglasii, Eriophyllum staechadifolium, Rosa californica, Salvia sp., Mimulus sp., Eriogonum sp., Frankenia salina* and *Leymus triticoides*. The active planting work proposed in this plan will be augmented by the natural, passive revegetation that occurs in most tidal marshes, and especially those treated for non-native *Spartina*.

3.2.1 Considerations for Donor Plant Sources

Sources of plant material, including donor seed, cuttings, or ramets[3] should be native and "local". However, the appropriate locality varies with the species and its natural modes of dispersal in the

Table 2. Potential Reference Sites

Site Name	Reference Features	Clapper Rail Data
Sonoma Baylands, North Bay	Recently restored by levee breaches (1996), uninvaded tidal marsh	Not present
Napa Salt Ponds -2A, North Bay	Recently restored by levee breaches (1995), uninvaded tidal marsh	Not present
Carl's Marsh, Petaluma River	Recently restored (1994), uninvaded tidal marsh, enclosed by levees	Present, surveyed since 2007
Bahia Channel, Marin Audubon	Older restoration (1980s), uninvaded tidal marsh, narrow linear marsh channel, bordered by levees	Present, surveyed since 2005
Muzzi Marsh, Corte Madera Ecological Reserve	Older restoration (1976), insignificant *Spartina* invasion	High density, surveyed since 2005
Faber Marsh, Palo Alto	Older restoration (1969), insignificant *Spartina* invasion	High density, surveyed since 2005
McInnis Marsh/Hamilton South, Novato shoreline	Mature marsh, uninvaded tidal marsh	High density, surveyed since 2005
Heerdt Marsh, Corte Madera Ecological Reserve	Mature marsh, insignificant *Spartina* invasion	High density, surveyed since 2005
Laumeister Marsh, Palo Alto	Mature marsh, insignificant *Spartina* invasion	High density, surveyed since 2005
China Camp State Park, Marin	Ancient marsh, uninvaded tidal marsh	Mod/high density, surveyed since 2005

[2] The TAC met on October 13, 2011 to review and advise on an October 5, 2011 version of this plan, and two workgroups, Monitoring and Clapper Rails, and Planting Design and Propagation, met subsequently on November 17 and 18, 2011 to provide additional specific guidance. The TAC and workgroup members are listed in **Appendix 2**.

[3] A "ramet" is an individual plant that has grown vegetatively from another individual as a clone of that plant. Multiple stems of a ramet are connected by rhizome or aerial stem.

environment. Because seeds inherently provide greater genetic variation than cuttings or ramets, and because they are less expensive to acquire, the project will use seed for both broadcast seeding and nursery propagation, where feasible. However, given the urgency to establish large, mature plants as quickly as possible, vegetative plugs or ramets will be used for nursery propagation as well as direct transplants into selected sites in the near term. To increase the genetic diversity in these cases, ramets, cuttings, and seed will be collected from multiple plants and sites to ensure the inclusion of multiple genotypes and help ensure adequate outcrossing.

3.2.2 Considerations for Spartina foliosa Revegetation

Spartina foliosa, a critical component of native clapper rail habitat, will be actively reintroduced in regions where it has been extirpated and where invasive *Spartina* has been sufficiently removed. There is little recent research on *S. foliosa* restoration in San Francisco Bay and most tidal marsh revegetation has been passive (e.g., no active planting). To guide development of this restoration plan, ISP conducted an extensive literature review of *S. foliosa* research and restoration efforts, which is included as **Appendix 3.**

Planned reintroduction of *S. foliosa* will be restricted to areas where the occurrence of hybrid is confirmed to be minimal, manageable, and detectible. Planted sites will be carefully monitored for presence of non-native genetic material and continued genetic testing of planted areas will be included in the monitoring program.

While the preference is to use local donor plant sources, hybrid *Spartina* has effectively dominated and displaced *S. foliosa* in the majority of Central and South Bay marshes, resulting in very few local, genetically pure *S. foliosa* sites remaining. Thus, the nearest local, genetically pure populations will be used. Recent genetic research using microsatellites (Sloop et al. 2011), suggests that *S. foliosa* is genetically depauperate throughout its range. This confirms earlier research by Antilla et al. (2000) using RAPDs (Randomly Amplified Polymorphic DNA) that found very little nuclear genetic diversity for *S. foliosa*. Sloop is continuing this research with additional Central and South Bay *Spartina* samples provided by the ISP, in an effort to determine whether source plants collected from the North Bay may appropriately be planted in the Central or South Bay (Sloop, pers. comm. 2011).

3.2.3 Planting Design

The planting design focuses on enhancement of the microhabitat zones described in Section 1.6 that will provide the greatest benefit for clapper rail. Planting layout design will vary according to site specific conditions and opportunities for enhancement of rail habitat. Planting will occur in the following microhabitat zones where appropriate.

Channels: *G. stricta* will be planted along the upper banks of channels to supplement existing cover and nesting substrate for clapper rails. *S. foliosa* will be planted along the sloping banks of tidal sloughs, and bay ward edge, to provide additional cover along channels. These channels also function as corridors for clapper rail movement and foraging and for the transport of native seeds throughout the marsh. Plantings along channels will include:

- A 1-m wide *G. stricta* zone for channels at higher elevation for nesting, cover, and high tide refugia
- A 2 to 10-m wide (bayward edge) *S. foliosa* fringe for lower elevation/wide channels
- A 1 to 2-m wide *S. foliosa* planting zone in the low marsh zone within channels.

Mid to High Marsh Zone: *G. stricta* will be planted in the mid to high marsh around higher elevation islands and along levees. Thick patches of *G. stricta* will function both as high-tide refugia and nesting substrate. Reference sites that support a high density of clapper rail in San Pablo Bay are characterized by mixed stands of *Bolboschoenus maritimus* and *S. foliosa*. Thick monocot stands provide excellent cover and nesting substrate, and plantings are also recommended to test whether *B. maritimus* can be established at some sites with lower salinity levels. The high marsh offers an opportunity to experiment with other methods of establishing vertical structure for high tide refugia. For example, planting a creeping monocot such as *Distichlis spicata* at the base of preexisting vertical structure could increase cover provided to clapper rail. Many of the nests found in native marshes during the 2007-2008 USGS telemetry study were found in dead or live *G. stricta* skeletons interwoven with *D. spicata* (T. Roemer pers. comm.). The placement of dead branching brush of similar size to *G. stricta* can be tested to mimic this natural condition at sites where skeletons of *G. stricta* are lacking. Plantings in the mid to high marsh will include:

- A 1-m wide *G. stricta* zone at higher elevation for high tide refugia, nesting and cover
- A 1-m wide *G. stricta* zone along levees and upland islands for high tide refugia and nesting
- Planting clusters of D. spicata near *G. stricta* plantings at select sites.

Additional future mid to high marsh plantings could include *Distichlis spicata*, *Triglochin maritima*, *Frankenia salina*, and *Scirpus maritimus/Bolboschoenus maritimus (*mid marsh*).*

Marsh - Upland Transition Zone: Plantings in these areas will benefit clapper rail by providing cover during extreme high tide events. Planting a variety of species is recommended for many reasons, including weed suppression and soil amendment. Planting palettes will be developed depending on site specific near term planting goals. Goals may include providing refugia from extreme high-tide events and barriers to terrestrial predators, while not providing perches for avian predators. Plantings in the marsh - upland transition zone will include:

- A 1-3-m wide marsh-upland transition zone plantings for high tide refugia. Possible planting palette includes *Artemisia californica*, *Baccharis douglasii*, *Eriophyllum staechadifolium*, *Rosa californica*, *Salvia* sp., *Mimulu*s sp., *Eriogonum* sp., *Frankenia salina* or *Leymus triticoides*.

Planting Propagation, Configuration and Installation: To achieve the maximum clapper rail benefit rapidly from planting, a high-density, cluster planting configuration will be used for plantings of *S. foliosa*, *G. stricta* and selected transition zone species.

Grindelia stricta will be primarily propagated by seed in nurseries. *G. stricta* planting will also involve the use of larger, more mature plants to provide both immediate vertical and horizontal plant structure for the rail and allow for more rapid establishment of seed-producing individuals (though more mature plantings may experience greater transplant shock). Spacing of transplants will be similar to smaller out-planted plugs and can be modified as necessary. Additionally, mature plants or seedlings may be interplanted with dead “small woody debris” such as harvested *G. stricta* skeletons or other cuttings anchored to the marsh substrate.

Grindelia stricta will be planted in patches that are 1 meter wide and approximately 5 meters in length. The Technical Advisory Committee recommended planting *G. stricta* patches approximately 40 meters apart, based on territory use derived from rail telemetry data (Laumeister Marsh, C. Overton/USGS data). This will maximize benefit to potentially multiple pairs of rail within a site by spacing the dense planting clusters. Within the linear patches, the *Grindelia* will be planted in clusters of 4 plants per square meter. Within each cluster, 20 individual *G. stricta* plants will be planted. Eventually the most successful of the plants may exclude their neighbors or limit their growth, but in the short term the density provided by the smaller, young plants will provide valuable benefits to clapper rail and other wildlife, and will create a greater in-marsh seed source that can disperse naturally to other appropriate areas of the site.

Spartina foliosa plants will be grown from seed, rhizomonous fragments, or whole shoots at a nursery. In order to maximize benefit to clapper rails in terms of foraging habitat, *S. foliosa* will be transplanted at high densities and in plug form. Each plug will contain 2-6 ramets *of S. foliosa*. Two distinct low marsh areas will be planted with *S. foliosa*: interior channels and fringing marsh.

In young marshes, channels tend to be linear with few cut banks. In these channels, plugs will be installed every 0.5m along 1m wide parallel transects. The number of transects will vary with the width of the channel, but there will generally be 1-3 transects per channel. This planting configuration requires two to four plants per meter of channel per bank, with smaller channels planted in a linear fashion. In older marshes with sinuous channels, special consideration is needed due to the existence of sloped and cut banks. For these sites, *S. foliosa* will be planted in high-density nodes on sloped banks. Sloped banks that are near small channels suitable for clapper rail nesting will be preferentially planted. Four plugs per meter squared will be planted on suitable banks.

Spartina foliosa plantings in larger channels or along the hydrologic gradient of flood control channels will be installed every 0.5 m on transects in several parallel rows, with the number of rows determined by channel slope. High wave energy sites may benefit from planting *Spartina* plugs with an additional treatment such as rock, shell or bamboo stakes to anchor the root ball. Goose herbivory prevention methods will also be applied as needed. In addition, *S. foliosa* planting time will be tested, including early vs. late season (January/Feburary vs. April) installations. *Spartina foliosa* planting treatments and methods will be informed by the most current research and by partners (SFSU, UCD, STB), local tidal marsh restoration ecologists, and the Technical Advisory Committee.

Planting layouts and strategies for the mid-marsh and marsh-upland transition zone plantings will be linear patches of cluster planting (minimum of 5m in length) of the selected site-specific species. Initially, planting will be composed of plugs with a limited palette of available nursery propagated seedlings, and future planting years will incorporate a more diverse species palette as well as direct seeding. Transition zone plantings will be sited in locations that are determined to be (using best available data) appropriate for use as high tide refugia for clapper rail. Transition zone planting design and methods will continue to be informed by research, partners, and the Technical Advisory Committee.

The species proposed in this design have specific marsh elevation and inundation tolerances that dictate appropriate locations for planting. The appropriate elevations have been estimated using available GIS, aerial imagery, expert opinion and ground truthing using natural occurrences within the marsh. Planting designs will be adapted as further relevant elevation questions arise and more research becomes needed or as other data becomes available.

Planting within all marsh zones will be timed seasonally to avoid disturbing breeding or nesting California clapper rail. In marshes where clapper rails are present within 500 meters of the planting area, installation will typically be scheduled for completion prior to the beginning of breeding season, and no later than mid-February. Where clapper rails are potentially present but at a distance of greater than 500 meters, planting may continue through the end of February, but every effort will be made to complete work as early as possible. Planting within the marsh-upland transition zone in proximity to clapper rail populations will be completed as early in the year as possible, but may continue into April if necessary, and if no rails are disturbed. Planting at marsh or mash-upland transition locations where clapper rail are absent will be scheduled at any time, based on environmental and other factors.

"Conservation Measures" to protect California clapper rails and other species of concern have been developed and will be implemented throughout all phases of planting and maintenance (**Appendix 4**). All revegetation work within or adjacent to clapper rail habitat will be planned with and supervised by a senior clapper rail biologist, who will assure implementation of Conservation Measures and have authority to discontinue work at a site if measures are violated or clapper rails are found to be disturbed. USFWS will make the final determination regarding Conservation Measures and timing of plantings within each planting zone and/or marsh.

3.2.4 Site-Specific Planting Plans

ISP staff worked with marsh managers, stakeholders, and expert advisors to select and develop detailed site-specific planting plans for 14 priority treatment sites in 2011-2012, including: Cogswell Marshes (20m and 20o), Alameda Flood Control Channel Mouth, Lower and Upper (01a, b, c, counted as one site), Greco Island North (02f) and Bair Island-B2 North (02c), Whale's Tail marshes (13e and 13d), Eden Landing Ecological Reserve (13k and 13j), Old Alameda Creek Island (13b), Oro Loma marshes (07a and 07b), Colma Creek (18a) and Elsie Roemer Bird Sanctuary (17a). There are an additional 10 partner-led revegetation sites including: Creekside Park (04g), Arrowhead Marsh (17c), MLK Marsh (17h), East Creek Slough (17d.3), Damon Marsh/MLK Shoreline (17d.4), Faber/Laumeister (15b), Palo Alto Baylands (08), Ravenswood Open Space Preserve/SF2 (02j), Bothin (23j), and Eden Creek Marsh (13l).

To develop detailed estimates for the number of plants and amount of labor required for each site, ISP used a Geographic Information System (GIS), available aerial imagery, and the most recent non-native *Spartina* inventory and clapper rail location data from surveys. Proposed planting areas were digitized using the design criteria described above. The resulting digitized areas were then quantified and used to calculate the number of plants required. The placement and design of each digitized "patch" were dictated by the design criteria, but for the first season, the number of patches and total area to be planted was constrained by the number and types of plants available from nurseries. The plans exist graphically in GIS produced maps (**Appendix 5**), and details regarding the planting palette, plant source, planting zone, estimates of plant numbers, installation timing, and other important information are managed in the Program's "Revegetation Site Specific Planning Matrix" (**Appendix 6**). The site specific plans are currently being "ground truthed" by ISP biologists to assure that features mapped on the GIS are consistent with and appropriate for the features as they exist in the field. The Matrix and maps will continue to be adapted and corrected based on field conditions and other criteria.

3.3 Success Criteria

The Restoration Program has developed a number of short-, intermediate-, and long-term "success criteria" or "performance objectives" to facilitate adaptive management and measure the success of revegetation projects across sites (**Table 3**). Project performance relative to the success criteria will inform subsequent revegetation efforts, and may be used by USFWS during review of the *Spartina* Control Program under Section 7 of the Endangered Species Act. Although the criteria were developed with the primary objective of assessing rapid establishment of enhanced cover, nesting, and high tide refugia habitat, some also are expected to assess progress towards long term development of the diversity and complexity of a native tidal marsh community.

Table 3: Success Criteria for ISP Revegetation Sites

Timing	***Criterion***	***Description***
Short Term (2011-2013)	1A: Planting survivorship	A minimum of 40% survivorship is expected for active revegetation. If this criterion is not met, planting to achieve this target will occur the year following initial planting.
	1B: Growth and maturation of plantings	Measuring plant growth and maturation (e.g., percent cover and plant height) is needed to ensure that plantings are thriving and thus will eventually provide habitat value for clapper rail. Metrics of success will include comparison with size of a given plant species at an appropriate reference site.
	1C: Passive revegetation with native marsh species	Sites should experience an increase in cover over time via passive revegetation of native plant species.
Medium Term (2013-2015)	2A: Plant densities and vertical structure providing clapper rail habitat	Species-specific metrics (e.g., for *G. stricta and S. foliosa*) to be determined by monitoring native plant characteristics at reference sites that support populations of clapper rail.
	2B Continued lateral growth and maturation of plantings	Measuring plant lateral growth, maturation, and planted area expansion.
	2C: Clapper rail presence at new or restored sites	Detection of clapper rails at young restoration sites or restoration sites that have been reset by removal of extensive stands of invasive *Spartina* as determined by call count surveys.
Long Term (2015-2020)	3A: Self-sustaining plant populations (i.e., reproduction and recruitment of propagules from restoration plantings)	In monitoring areas not directly planted with the various natives (e.g. *S. foliosa*, *G. stricta,* etc.) the establishment of those species indicates successful intra-site dispersal from mature plantings.
	3B: Increase in clapper rail numbers as determined by call count surveys	Annual Baywide call count surveys should detect an increase of 150 birds Baywide in 10 years (baseline year of 2010).
	3C: Clapper rail presence at new or restored sites	Detection of clapper rails at young restoration sites or restoration sites that have been reset by removal of extensive stands of invasive *Spartina* as determined by call count surveys or other approved methodologies.

Short-term success criteria will focus on planting survivorship, growth and maturation of planting and continued passive revegetation that will provide and enhance clapper rail habitat.

In the ***medium term***, the rate of plant growth and maturation is a measure of the success toward providing the intended habitat enhancement, which is large/mature vegetation. If the plants just barely survive but fail to grow and reach a mature size, they won't provide the height and density needed to support clapper rail. In addition, plantings that are not growing or expanding will not export sufficient seed to other areas to support a self-perpetuating and stable population. If feasible, benchmarks for clapper rail habitat will be identified and tracked in the course of monitoring work. Monitoring reports will identify whether supplemental plantings or replacement plantings are needed if the original installations do not meet the success criteria. There is likely to be a "lag-time" between any planting effort and the achievement of an established, self-perpetuating population of desired plants. Dense plantings of target species may serve to speed up the colonization of the site, offset expected mortality of some transplants, and provide structural complexity to the revegetated area during this lag period. Success of plantings and overall restoration success will be evaluated via analysis of monitoring results and comparison to set success criteria.

Table 3: Success Criteria for ISP Revegetation Sites (continued)

Timing	Criterion	Description
Maintenance Success Criteria	4A: Return to unvegetated mudflat or channel bottom at suitable elevations	Completion of hybrid *Spartina* eradication in low-elevation areas indicates successful restoration to their natural condition as unvegetated mudflats or channel bottoms.
	4B: Removal and continued exclusion of non-native *Spartina*	Refers to maintenance of the eradication of non-native and hybrid *Spartina.*
	4C: Removal and control of other invasive plants within planted areas (e.g., marsh - upland transition zone)	Marsh-upland transition zone planting areas will require monitoring and weed removal to allow for successful planting establishment. Initial goal will be to achieve and maintain <10% cover of invasive plants that are detrimental to the establishment of habitat for California clapper rail.
Adaptive Program Management Criteria	5A: Research and development of best propagation and planting techniques	Propagation and planting techniques will be adapted to implement the best possible methods to increase efficiency and ensure rapid habitat creation.
	5B: Continued development and implementation of revegetation plans	Revise plans based on continued input from external review and monitoring data results (adaptive management framework).
	5C: Development and implementation of long-term monitoring plans	Monitoring plans will incorporate baseline vegetation data for revegetation sites, clapper rail monitoring data, and the longer term development of revegetation sites.

Five types of monitoring will be included: 1) revegetation photo point monitoring, 2) survivorship monitoring, 3) planting method assessment monitoring, 4) habitat assessment monitoring and 5) California clapper rail monitoring. Monitoring will also inform the maintenance and adaptive management of the revegetation efforts. Monitoring methods are described in detail in Section 8 of this document.

Longer term success criteria will center on the natural, passive dispersal and establishment of the reintroduced native plant(s) at other locations within ISP revegetation sites. In addition to reestablishment of the native marsh community, if pre-invasion or baseline data/photos are available, the target community will be site-specific, pre-invasion plant and animal community assemblages. This will be most readily identifiable in the form of *S. foliosa*, which at many sites has either been extirpated from the area by the non-native *Spartina* invasion or has not had a chance to establish in a newly opened/restored marsh. The presence of *S. foliosa* in any areas not specifically planted with this species will be considered as a successful outcome of the revegetation effort. To establish that native *S. foliosa* has indeed migrated or passively recruited from planted areas, the genetics of any *S. foliosa* planting areas and putative colonization sites will need to be monitored to ensure that hybrid *Spartina* is not allowed to establish and thrive. The genetic results should be compared to the data collected from the source population (either where ramets or seeds were harvested from) and tracked over time.

3.3.1 Clapper rail success criteria

Success criteria relating to clapper rail response to revegetation activities have been under review by the Technical Advisory Committee and USFWS. The USFWS provided comments on the Draft Restoration Plan and provided specific direction to inform the target criteria for this program, including setting the California clapper rail success criterion "to increase the Bay-wide

California clapper rail, over the 2010 call count average, by 150 over a 10 year period. Statistical significance will not be required to determine if and when this criterion has been met."

Occupancy by clapper rail at revegetated sites, as determined by yearly call count surveys or other USFWS approved methodologies, will be defined as a medium- and longer-term success criteria for the revegetation efforts (passive and active combined). In the longer term, it is expected that clapper rail will continue to use revegetated areas and that numbers as determined by yearly call count surveys or other methodologies, will increase. Rail occupancy in revegetated sections of the marsh must be calibrated to reflect the understanding that a healthy native marsh assemblage is unlikely to ever support the high rail densities that have been observed at some non-native *Spartina* invaded sites. The most likely positive outcome is that clapper rail densities following non-native *Spartina* removal will be similar to site-specific pre-invasion densities and population numbers.

3.4 Research and Management Questions

Revegetation projects will be designed to consider specific questions, including the following:

Plant Collection & Propagation

- What are the most appropriate donor populations for *S. foliosa*?
- What are the most effective collection times?
- Do collection site conditions affect propagation vigor and transplant survivorship?
- What is the most efficient and cost-effective propagation method for target species?

Planting

- How does seedling/plug size relate to survivorship?
- Which microhabitats within target marshes maximize survivorship of plantings?
- What are the most effective planting times?
- Do large *G. stricta* plantings experience survivorship rates similar to plugs across microhabitat types?
- How does introduction of small woody debris affect survivorship of transplants?
- How does planting density affect survivorship of transplants?

Clapper Rail Response to Revegetation

- If possible, what methods would be necessary to assess how clapper rail numbers respond?
- Longer-term: how does a passively revegetated site compare to an actively revegetated site in terms of rate of re-establishment of clapper rail habitat?
- Longer-term: how do actively revegetated sites compare to reference sites in terms of amount and quality of clapper rail habitat?

Additional related wetland revegetation research and monitoring results, for example with Save The Bay, The Watershed Nursery, UC Davis, Romberg Tiburon Center /San Francisco State University, PRBO Conservation Science, and USGS, will also continue to inform the management of this restoration program.

4 MONITORING PROGRAM

Five types of monitoring will be included in this program: 1) revegetation photo point monitoring; 2) survivorship monitoring; 3) planting method assessment monitoring, 4) habitat assessment monitoring and 5) California clapper rail monitoring. Reference sites will also be monitored to help guide and adapt the planting plans and track passive revegetation. Baseline monitoring will be conducted prior to revegetation efforts.

4.1 Revegetation Photo Point Monitoring

Photo point monitoring will be conducted at all active revegetation sites, and at a sampling of passive revegetation sites and reference sites, to provide documentation of change over time. Permanent revegetation photo points will be established at the revegetation sites prior to any active revegetation activities. Photos will be taken annually during the late summer-fall.

A minimum of two photo documentation points per revegetation site will be established to document site conditions prior to planting. The location of the photo documentation site will be documented using GPS and possibly marked with PVC pipe to facilitate relocation. The revegetation photo points will include any landscape features that are unlikely to change over several years (buildings, other structures, levee berms, trees, foot bridges, etc.) again, to facilitate relocation of the exact photo position.

Photos will be taken from these revegetation photo points at the same camera angle each monitoring year, using a compass bearing at the selected photo points, as appropriate to illustrate site conditions. Photographs will be taken from approximately 5 ft in height.

4.2 Survivorship Monitoring

Survivorship monitoring will be conducted at all actively revegetated sites to inform replanting needs within the first three years after planting. The objective of survivorship monitoring will be to assess the percent survivorship of actively-planted individuals for a period of three years at a sampling intensity to allow assessment accuracy of +/- 10% survivorship.

Initial baseline monitoring of all plantings will take place during planting or shortly thereafter, and subsequent survivorship monitoring will take place annually in the late summer-early fall.

Patch-specific planting information will also be documented at time of planting and will include:

- source plant location;
- source plant salinity/inundation regime/soil type;
- source plant age and phenology;
- propagation technique (e.g., transplant, vegetative bed, seed);
- planting technique and design (e.g., planting density);

The location, species, and number/density of all initial active plantings will be recorded using mapping-grade GPS data recorders and associated data forms. Subsequent survivorship monitoring will be conducted on a sampling of the initial plantings within a site, with the sample size to be determined based on a power analysis. The power analysis will measure percent survivorship to within a margin of error of 10% at the 95% confidence interval (i.e., it assesses percent survivorship to within +/- 10% of the true value, with a 95% likelihood of covering the true value in that range).

Using GIS, the statistically appropriate number of sampling locations will be selected in a stratified random design by marsh planting zone. A monitoring protocol describing data collection techniques will be defined based on the species and planting design and the results of the power analysis.

In addition, observations regarding plant health (e.g., vigor, evidence of herbivory, evidence of dieback of shoots, severe insect infestation, etc.) will be noted, particularly when poor health is an apparent indicator of imminent mortality.

An ANOVA or t-test, as appropriate, will be used to evaluate whether or not percent survivorship is less than or equal to the set target of greater than 40% survivorship, with the caveat that annual climatic variation may influence the percent survivorship.

4.3 Planting Method Assessment Monitoring

4.3.1 Quantitative Assessment

Marsh vegetation at active, passive and reference sites will be monitored to assess the efficacy of the revegetation methods across sites and marsh planting zones. Survivorship, cover, density, size and phenology (as a proxy for fecundity) will be used as measures of overall plant health of target species (those species planted at active revegetation sites). Plant species diversity and abundance will be measured as indicators of marsh ecosystem health and maturity.

The number of sampling locations and plots within each location will be determined using a power analysis based on similar, existing ISP-collected permanent plot monitoring data. Data will be collected every other year in late summer to early fall. Nested 1 x 1 meter and ¼ x ¼ meter plots

Figure 8. Survivorship of plantings is monitored to inform replanting needs and to help assess planting design and methods.

will be set and the following data parameters measured: maximum plant height (*S. foliosa or G. stricta*); number of culms (stems *S. foliosa*); maximum plant diameter (*G. stricta*); plant phenology (vegetative, flowering, seeding, senescing, etc.); relative vegetative percent cover, percent cover of all species (native and non-native); percent cover bare ground; and percent cover wrack. Factors such as salinity, soil composition, elevation, presence of woody debris, etc. will be noted to better attempt to correlate plant survivorship with environmental factors. These monitoring results will be used to try to answer research/ management questions and adapt the restoration program. Additionally, the vertical distribution of live vegetation will be recorded using a dowel (Wiens pole) to count the number of vegetation contacts (hits) within each 10 cm increment up to 1 m. A sampling of monitoring plots will be photo monitored (see Revegetation Photo Point Monitoring). ANOVA will be used to compare differences in measured values across sites and marsh zones.

4.3.2 Qualitative Assessment

Qualitative vegetative data will be collected each year at active and passive revegetation sites with the purpose of informing management and future revegetation efforts. These general site assessments are intended to assess the overall functioning of the site as a whole, and also to help identify localized or low-level trends such as new invasive species formations, localized changes in species abundance, and other revegetation or weed control management actions. Related observations of vegetation and habitat condition will be noted, including: patterns of plant die-offs, erosion, hydrological issues, herbivory, or other land use issues. This information is intended for use in recommending management actions as necessary.

4.4 Habitat Assessment Monitoring

Habitat assessment monitoring will include measuring a number of marsh parameters that are indicative of the overall marsh habitat quality and structure. As there will be a considerable lag time before significant habitat changes can be detected across all sites, habitat assessment monitoring is expected to take place every 3-5 years from September through November to avoid disturbing breeding birds.

Baseline data were gathered in 2005 at a subset of sites slated for revegetation, as well as several sites that are candidate reference sites (Spautz and McBroom, 2006). All sites slated for revegetation, as well as reference sites that were sampled in 2005, will be revisited in 2011 to assess the progress of passive revegetation and to establish a baseline for active revegetation efforts.

Vegetation and habitat structure metrics will be collected within 50 meter radius random plots and adjacent channels (modified relevé method developed by PRBO Conservation Science). At each sampling plot, the percent cover of each plant species (expressed as a proportion of all vegetation), the percent cover of unvegetated mudflat, and percent cover of tidal channel within the four quadrants of the 50 meter radius plot will be measured.

Channel metrics will also be recorded, including the distance to the nearest tidal channel from the center point of the 50 meter plot, and the width of the channel.

Finally, two types of height measurements will be taken at nine sub-sampling points (placed at the plot center and 10 m and 30 m from the center on four perpendicular transects radiating from the center, starting with a randomly-chosen angle): (1) the vertical distribution of live vegetation will be recorded using a dowel (Wiens pole) to count the number of vegetation contacts (hits) within 10 cm increments of the dowel up to 1 m and (2) the maximum vegetation height within 1 m radius of the subplot will be recorded.

4.5 Clapper Rail Monitoring

The ISP's ongoing California clapper rail breeding season surveys will document the use of re-vegetated sites by clapper rail, and will continue to provide an indication of population trends within some site complexes and specific regions. USFWS may recommend new protocols to survey for clapper rail in the Estuary such as the National Secretive Marsh Bird Monitoring Protocol (Conway, 2009) which will allow for better detection of clapper rails as well as other rail species. Additional methods for assessing clapper rail response to revegetation activities are under review by the USFWS, who will provide specific direction to inform the monitoring program. Implementation of this plan is expected to result in a detectable increase of about 150 clapper rail in Central / Southern San Francisco Bay Recovery Unit over the next ten years.

4.6 Monitoring Schedule

Habitat assessment monitoring will take place from April through November, and revegetation photo points, survivorship and planting method assessment monitoring will take place in August to October (**Appendix 7**). Some flexibility in this schedule will be necessary to accommodate annual variation in weather conditions and plant growth.

5 MAINTENANCE

The ISP is, in a very real sense, the cost of deferred maintenance on previous restoration and revegetation work in the San Francisco Estuary. The initial introduction of non-native *Spartina* done by the Army Corps of Engineers was a revegetation activity that was unmaintained. The restored tidal marshes where the ISP focuses much of its work were opened to tidal action with insufficient maintenance strategies in place to keep non-native *Spartina* from invading or to control it once it came in. As a result, it was necessary to create the ISP at great and continuing cost to remediate the effects of these un-maintained revegetation and restoration efforts.

Committing to a maintenance strategy and budget is an integral component to any successful revegetation effort. The maintenance strategy associated with the effort should be integrated into all aspects of the project, from planning to implementation to the actual maintenance phase. Initial project work will more clearly define the overall cost structure for subsequent planting seasons beyond the 2011-2012 season, but a solid maintenance strategy and proposed methodology could be in place much earlier.

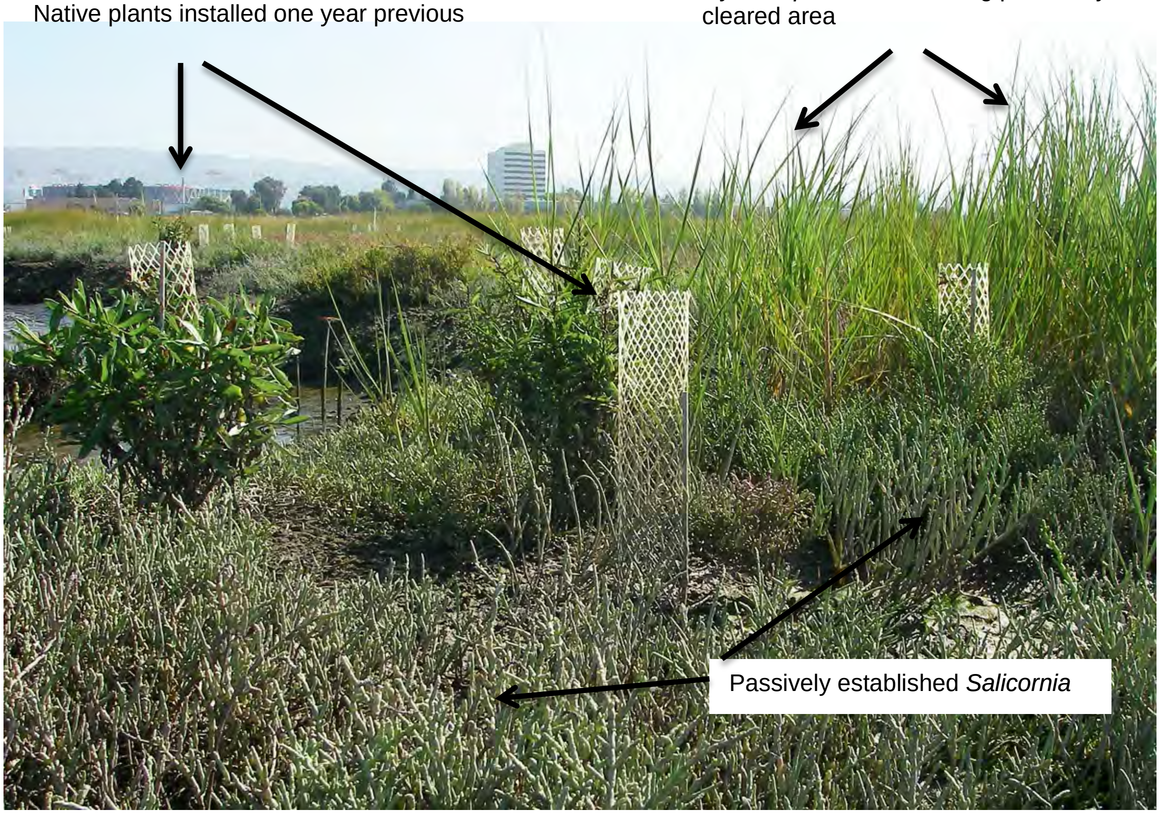
Much of the maintenance effort for native *S. foliosa* plantings will be related to the control of non-native *Spartina* proximate to the planted areas. This responsibility is already within the scope of responsibilities of the ISP's *Spartina* Control Program and partnerships and would not need to be significantly modified to include the areas of the marshes proposed for revegetation efforts. The areas that are planted with *G. stricta* and/or other marsh plant species will likely require maintenance work beyond the current purview of the *Spartina* Control Program, in that other non-*Spartina* weed species may require control to enhance the success of the plantings. East Bay Regional Parks District, Save The Bay, and others will work with the State Coastal Conservancy to control any other non-native species that threaten the success of the revegetation effort.

Components of the revegetation management strategy include the following:

- Using appropriate herbicide or manual removal methods to control non-native weedy plant species prior to, during, and after planting. . Examples of non-native weedy plants include:
  - *S. alterniflora x foliosa* (smooth cordgrass hybrids)
  - *Lepidium latifolium* (perennial pepperweed, whitetop)
  - *Limonium ramosissimum* (Algerian sea lavender) and hybrids
  - *Raphanus raphanistrum* (wild radish)
  - *Foeniculum vulgare* (wild fennel)
  - *Carpobrotus spp.* (iceplant)
  - *Salsola soda* (saltwort)
  - *Tetragonia tetragonioides* (New Zealand spinach)
  - Other weedy species as necessary
- Providing limited control of native plant species that may decrease the success of planted areas, including possible thinning of native plantings as necessary (e.g., *G. stricta*).
- Facilitating irrigation of planted seedlings, especially *G. stricta* or others planted on higher elevation zones less regularly inundated with daily tides, if necessary and on a limited basis.
- Controlling herbivory where practicable (e.g., caging seedlings to minimize Canada goose grazing).

Figure 9. Left: A contractor using a gasoline-powered weed trimmer to remove weeds while preparing a levee berm for planting with marsh-upland transition zone species. This may be followed in subsequent weeks with additional mechanical treatment or with spot treatment of appropriate herbicide.

Below: An example of an area previously planted with *Grindelia* and *Triglochin* (in wire netting cages) being encroached by regrowth of hybrid *Spartina*. Maintenance would include repairing damaged cages, removing cages of sufficiently large plants, and carefully spot-treating encroaching hybrid Spartina to protect the plantings.



6 TIMELINE

Activities associated with the revegetation will occur year-round (**Appendix 7**). Monitoring, planning and maintenance activities will be scheduled throughout the year, whereas planting will generally occur during the rainy season, roughly from November through April but dependent on the specific seasonal conditions each year. Specific implementation goals over the coming decade include the following:

6.1.1 Short Term (July 2011 - April 2012)

- Initiate revegetation projects, including site preparation, installation, and maintenance actions as described.
- Grow and plant species that will benefit clapper rail, including *G. stricta* and *S. foliosa* as well as other appropriate high marsh and marsh-upland transition zone species.
- Develop site-specific revegetation plans and budgets for initial revegetation sites.
- Develop a strong monitoring program to assess progress and answer key questions regarding planting designs and methods to achieve optimal planting success and maximize enhancement of clapper rail habitat.
- Work with USFWS, land owning site partners, the Technical Advisory Committee, Save The Bay and other partners to develop and refine general and site-specific (where appropriate) performance objectives and associated monitoring protocols.
- Establish a revegetation partnership network.

6.1.2 Medium Term (April 2012 – March 2014)

- Expand revegetation within initial project sites and begin work at additional priority sites each year, using revegetation methods determined by initial projects to be most effective.
- Expand contracts with nurseries as necessary to produce sufficient large quantities of native plants for installation at project sites.
- Refine monitoring methods and use results to improve planting success and better achieve project objectives.
- Maintain planted areas, including weed and herbivore control as necessary. Weed control will continue to be necessary before planting and during several growth seasons, and may include manual removal and herbicide application.
- Continue to work with partners and the Technical Advisory Committee to improve and refine the project.

6.1.3 Long Term (2015-2020)

- Continue to monitor and maintain sites, measuring performance against the established objectives.
- Previous plantings should meet all short- and medium-term success criteria and most of the planted areas should contain self-perpetuating populations of target plant species. Modify the Restoration Plan and management methods, including augmenting plantings or take additional corrective action as needed to meet performance objectives.

Exhibit 2

7 REPORTING

Brief annual reports will be provided to the U.S. Fish and Wildlife Service, partners, stakeholder groups, and the general public, and will contain status and data for all aspects of this restoration plan (floating islands, construction planning, predator control, and revegetation projects). Limited hardcopies of each report will be produced, and all reports will be provided online at the ISP website (www.*Spartina*.org). The reports typically will include a summary of the data collected at the project sites and assess progress toward short-, medium-, and long term success criteria and performance objectives. Photographs of revegetation sites will be included as necessary to document site conditions.

Exhibit 2

8 BUDGET AND FUNDING

Conservancy has established a budget of $1,000,000 to initiate the floating islands, construction planning, predator control coordination, and pilot-scale revegetation work from October 2011through April 2013. The results from these efforts will provide the basis to finalize strong design and monitoring criteria for a scaled-up approach in future years. In the third year and subsequently until the project reaches a self-sustaining condition that satisfies the success criteria described above, a very general estimate of $300,000 per year investment could be envisioned.

The Coastal Conservancy has continued to support the ISP and the development of this Restoration Program. Since 2000, a total of $20 million in state and federal funds has been authorized for invasive *Spartina* monitoring and treatment through March 2013. At the September 22, 2011 State Coastal Conservancy Board Meeting, the Board approved $1,000,000 in funding in support of restoration planning and implementation. This funding will support multiple partners, one year of floating islands studies, initial planning to assess construction opportunities and other methods to enhance rail habitat, and the first two years of expedited initial research and revegetation efforts.

The Coastal Conservancy, East Bay Regional Park District, Save The Bay, Friends of Corte Madera Creek, and the California Wildlife Foundation will work together to pursue additional funding opportunities, such as the USFWS National Coastal Wetlands Conservation Program, to complete the planned clapper rail habitat enhancement and restoration projects through 2016 .

Exhibit 2

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Examples of Previous Revegetation Projects by ISP and Partners

Figure 4. *Grindelia* and *Triglochin* plantings at Arrowhead Marsh West, Oakland, 2010. The collaborative effort was coordinated by Save the Bay. *Right*: Members of the planning and implementation team (from left to right): Jeanne Hammond, Invasive *Spartina* Project; Laura Wainer and Denise Della Santina, Save the Bay; Peter Alexander, East Bay Regional Parks District; Toby Rohmer, Invasive *Spartina* Project; and Cory Overton, US Geological Survey.

Figure 5. Left: High tide refugia planting on the upland edge of the newly-opened Eden Landing preserve. Right: Three generations of refugia plantings at MLK New Marsh. Both sites are in the San Leandro Estuary in Oakland.

Figure 6. Channel construction and Grindelia planting at Elsie Roemer Wildlife Sanctuary, Alameda. Channels with berms were built in 2006 to provide marsh elevations suitable for native marsh vegetation after removal of extensive hybrid *Spartina* meadows. Grindelia was planted in 2007 and 2008, and annual and perennial pickleweed established naturally. In 2011, once the hybrid was predominantly under control, experimental plants of *Spartina foliosa* began (figures 4 and 5).

APPENDIX 1

Figure 7: Several areas of Cogswell Marsh (Hayward) were planted with *Grindelia stricta* seedlings in January 2006, and *Gindelia* seeds were broadcast through the marsh that year and the next. Approximately 800 seedlings were installed on a half-acre area. *Grindelia* is now beginning to establish within the planted areas, and beginning to spread to other parts of the marsh.

Figure 8: Collection of *Spartina foliosa* plugs at Harriet Mundy in Palo Alto, CA in 2011. Picture on right shows DNA collection. For each donor site, 12 DNA samples were taken.

Figure 9: Planting *S. foliosa* at Colma Creek in South San Francisco. Site was planted with two donor populations of *S. foliosa*. *Right*: Complete *S. foliosa* plot. 60 plots were planted at Colma Creek, and 75 were planted at Elsie Roemer, in Alameda.

Exhibit 2

APPENDIX 2

Invasive Spartina Project: Technical Advisory Committee for Restoration Planning

Participant List updated 11/15/11 ML

Invited TAC Participants			Working Groups		Meeting Attemdance	
First Name	*Last Name*	*Attended 1st TAC 10/13/11*	*Monitoring and Clapper Rails*	*Planting Design and Propagation*	*Monitoring and Clapper Rails 11/17*	*Planting Design and Propagation 11/18*
Joy	Albertson	x	x		x	
Donna	Ball	x	x	x	x	x
Peter	Baye	x				
Doug	Bell	x	x	x	x	x
Diana	Benner			x		x
Valary	Bloom				x	
John	Bourgeois	x				
Kathy	Boyer			x		x
John	Callaway					
Mike	Casazza	x	x		x	
Gretchen	Coffman					
Darcie	Collins	x		x		
Jules	Evens					
Laura	Feinstein	x		x		x
Leia	Giambastiani			x		x
Letitia	Grenier		x			
Ted	Grosholz		x		x	x
Ryan	Olah					
John	Parodi			x		
Andrew	Raabe		x		x	
Doug	Serrill			x		x
Howard	Shellhammer			x		
Christina	Sloop	x	x	x	x	x
Ben	Solvesky	x	x		x	
John	Takekawa	x				
David	Thomson	x		x		x
Laura	Valoppi	x	?	?		
Laura	Wainer	x		x		x
Julian	Wood	x	x		x	
Joy	Zedler			x		(x)
Guests:						
April	Robinson				x	
Paul	Kelly				x	
Cory	Overton				x	
ISP:						
Stephanie	Chen	x		x		x
Jeanne	Hammond	x	x	x	x	x
Marilyn	Latta	x	0	0		x
Jen	McBroom	x	x		x	
Peggy	Olofson	x	0	0	x	x
Tobias	Rohmer	x	x		x	
Jude	Stalker	x		x		x
Erik	Grijalva	x	0	0		
Drew	Kerr	x	0	0		x
Whitney	Thornton	x		x		x
Katy	Zaremba	x	x	x	x	x
Ingrid	Hogle	x	0	0	x	x

A Review of Literature Related to *Spartina foliosa* Restoration in the San Francisco Estuary

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for

State Coastal Conservancy
San Francisco Estuary Invasive Spartina Project

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Exhibit 2

INTRODUCTION

Tidal salt marshes are ecosystems known for high productivity. They supply valuable services such as providing habitat to a multitude of organisms, buffering coastal zones from erosion and flooding, and transforming nutrients in biogeochemical cycles (Odum 1980, Zedler and Kercher 2005). However, in the San Francisco Bay, over 80 percent of these salt marshes have been lost (Goals Project, 1999). These marshes were casualties of 150 years of reclamation policy that promoted intertidal habitat drainage for agriculture, urban development, and industry. The few marshes left untouched suffer from hydrological regime change and invasive species introduction (Nichols et al. 1986, Williams and Faber 2001, Callaway and Zedler 2009, Strong and Ayres 2009).

In San Francisco Bay, Pacific Cordgrass, *Spartina foliosa,* is the dominant emergent plant at low elevation marsh zones (Hinde 1954). This native grass species provides habitat to the endangered California Clapper Rail (Foin et al. 1997). However, in this estuary, *S. foliosa* marsh zones have been highly compromised by introduction of Atlantic Cordgrass, *Spartina alterniflora.* This non-native grass was planted by the Army Corps of Engineers for flood stabilization in 1975 (Williams and Faber 2004). By the 1980s, *S. alterniflora* had expanded beyond its original planting site and soon after began to hybridize with the native *S. foliosa* (Callaway and Josselyn 1992, Ayres et al. 2003, Ayres et al. 2004). This introgressive hybrid backcrossed with *S. foliosa* and formed a hybrid swarm (Grosholz et al. 2009, Strong and Ayres 2009) that rapidly altered places in the San Francisco Bay. Hybrid *Spartina* modified the chemistry of sediment, changed hydrology, and altered marsh faunal communities (Grosholz et al. 2009, Grosholz 2009, Strong and Ayres 2009, Strong 2009). The infestation spread so rapidly that Ayres (Ayres et al. 2003) suggested that, without intervention, native *S. foliosa* would become the first naturally dominant plant species to go extinct in its own ecosystem since the passage of the Endangered Species Act.

Due to concerns about the negative effects of *Spartina* hybrids, the California Coastal Conservancy prioritized eradication of invasive cordgrass from the San Francisco Estuary through the formation of the Invasive *Spartina* Project (ISP) (Strong and Ayers 2009). While the impacts of hybridized *Spartina* have been greatest in Alameda and San Mateo counties near the original plantings of the Army Corps of Engineers (Callaway and Josselyn 1992), the infestation covered 800 acres at its maximum extent and included all parts of the estuary. By 2010, the Invasive *Spartina* Project and partners had eradicated more than 85 percent of known hybrid in the San Francisco Bay (Hogle 2011b).

BACKGROUND ON *SPARTINA FOLIOSA*

HISTORIC RANGE AND DISTRIBUTION

Spartina foliosa is endemic to the southern Pacific coast of North America. This cordgrass species is distributed in two distinct populations roughly 565 kilometers apart from each other (Vasey 2010). The northern population of Pacific Cordgrass is found from Bodega Bay in Sonoma County to the southern portion of San Francisco Bay in Santa Clara County. Pacific Cordgrass has colonized its northern two populations (Bodega Bay and Tomales Bay) within the last 40 years (Vasey 2010). However, both written accounts and herbarium specimens confirm *S. foliosa*'s historic presence in both Drake's Estero in Point Reyes and San Francisco Bay (Howell 1958, Vasey 2010). Historically, this plant had a widely dispersed, relatively continuous population in the extensive marshes that fringed the San Francisco Bay (Phillip Williams and Associates and Faber 2004). The southern distribution of *S. foliosa* extends from Mugu Bay in Orange County southward through a series of small bays and estuaries in Southern California and Baja California, Mexico. At the southern extent of its range, it co-occurs with tropical mangroves (Macdonald and Barbour 1974, Peinado et al. 1994).

There is much confusion in early literature about the northern distribution of *S. foliosa* due to an early introduction of a non-native cordgrass in Humboldt Bay. This population of *Spartina* in Humboldt County was misidentified as *S. foliosa* until as late as 1974 (Macdonald and Barbour 1974); however, by the mid-1980s, this population was suggested to be *Spartina densiflora,* a non-native from Chile. This misidentification was recognized following an intentional planting of the Humboldt variety of cordgrass at Creekside Park in Marin County (Spicher and Josselyn 1985, Williams and Faber 2001).

ECOLOGY

Spartina foliosa is a tall, perennial grass that forms wide, homogeneous plains at the bayward edge of marshes or narrow, uniform fringes along wide tidal sloughs (Hinde 1954, Mahall and Park 1976a, Atwater et al. 1979). Pacific Cordgrass is the only native emergent plant present in this coastal zone that corresponds roughly with the mean high tide water line (0.5-1.2 m NGVD) (Zedler et al. 1999). In order to survive the anoxic conditions of the low tidal zones, *Spartina* species have evolved a high proportion of aerenchyma tissue that allows for increased gas exchange at their roots (Mahall and Park 1976b). Indeed, *S. foliosa* can survive 21 hours of daily tidal submergence (Harvey et al. 1983). Cordgrass is replaced by *Salicornia pacifica* (formerly called *Salicornia virginica*) at higher marsh elevations. Mahall and Park (1976) suggest that Pacific Cordgrass is excluded from the high marsh by salinity while *Sacrocornia pacifica* is excluded from the low marsh by tidal flooding effects on seedling survival. In marshes with a gentle gradient change, *S. foliosa* can co-occur with *Sarcocornia pacifica* at middle marsh elevation zones (Baye et al. 1999). At this elevation, *S. foliosa* often appears in "dwarf" or stunted form (Cain and Harvey 1983).

The typical transitional zone between *S. foliosa* and the more salt tolerant *Sarcocornia pacifica* is 24 ppt (parts per thousand) (Mahall and Park 1976a). Native cordgrass can withstand salinities up to 35 ppt (equivalent to seawater). However, at this high a salinity, *S. foliosa* growth is highly stunted and seeds will not germinate (Cain and Harvey 1983). Lower salinities increase the growth rate, height, and germination success of this grass (Phleger 1971). Indeed, seeds of this species germinate at the highest rates in nearly fresh water (Crispin 1976). Once established, *S. foliosa* continues to grow late into summer as salinity increases. This growth pattern differentiates it from more brackish water species such as *Scirpus robustus* (*Schoenoplectus robustus)* which finish their growth cycles prior to high salinity summers (Pearcy and Ustin 1984). Despite the fact that cordgrass grows faster in fresher waters, it has a minimal presence in brackish marshes (Watson and Byrne 2009). This lack of presence in fresher parts of the estuary is likely due to the increased presence of better competitors not tolerant of higher salinities (Atwater et al. 1979).

Pacific Cordgrass growth habit is that of a perennial grass; this species typically senesces during fall or winter and grows new emergent stems from existing rhizomes in the spring (Mahall 1974). It spreads most rapidly and efficiently through rhizomatous growth, though it is capable of reproducing both asexually and sexually. Root fragments produce new shoots at their meristems. Additionally, *S. foliosa* is capable of producing fertile seed. In terms of San Francisco Bay area, *S. foliosa* flowers June through September (Anttila et al. 1998). Seed set tends to occur in October or November (Crispin 1976). This establishment of seedlings varies greatly with a year's weather conditions, and seedling establishment tends to be much higher in rainy years or in years with late rains; however, very few seedlings are generally observed of this species (Baye et al. 1999, Ward et al. 2003). Some of the reasons that *S. foliosa that seedlings might not be observed are as follows: S. foliosa* tends to produce relatively small amounts of pollen (Anttila et al. 1998), has a small seed bank presence (Hopkins and Parker 1984), and has low rates of germination in higher salinity waters (Crispin 1976, Trnka and Zedler 2000). Additionally, it has been speculated that *S. foliosa* has low seed viability after self -pollination (Daehler and Strong 1997). High seedling mortality may also be a problem. In a field germination experiment, Greer (1994) found that only 9 of 301 field germinated seedlings survived the summer.

COMPARISON OF *SPARTINA FOLIOSA* AND HYBRID *S. ALTERNIFLORA X FOLIOSA*

Much of the *S. foliosa* research within the San Francisco Bay in the past two decades has compared Pacific cordgrass ecological and morphological characters to those of *Spartina alterniflora* and its hybrids. The literature on this subject is vast and the information below is in no way intended to be comprehensive, but is rather an overview of the breadth of research relating to this topic. The following sections will briefly discuss transgressive characters within hybrid *Spartina*, identify some morphological characteristics of native versus non-native plants, and describe some differences in fauna associations between these two grass species.

Spartina alterniflora hybrids grow over a broader range of environmental characteristics than native *S. foliosa*. Thus, while *S. foliosa* grows in uniform monotypic stands along the bayward edge of marshes (Mahall 1974), hybridized *Spartina* is capable of growing at both higher (encroaching on pickleweed plain) and lower elevations (below mean sea level) (Callaway and Josselyn 1992, Ayres et al. 2008, Strong and Ayres 2009). Non-native *Spartina* also produces more vegetative biomass, has a wider variety of unique growth forms, and grows more rapidly in terms of lateral vegetative spread than its native counterpart (Callaway and Josselyn 1992, Anttila et al. 1998, Ayers et al. 2004). Hybrid *Spartina* is also more fit in terms of pollen and seed production. Antilla (1998) found that hybrid *Spartina* can produce 21 times more viable pollen than native cordgrass. Pollen from hybrid *Spartina* is capable of backcrossing with both of its parental species in order to produce viable offspring. Hybrid *Spartina* also exhibits a longer flowering time and a larger more fertile seed head than its native congener. Sloop (2005) noted that very few recruits of *S. foliosa* have been seen in the San Francisco Bay in the last decade; however, abundant recruitment by hybrid *Spartina* has been observed during this time.

The backcrossing of hybrid *Spartina* with its parental species has led to considerable overlap between the morphologies of native and hybridized *Spartina*(Zaremba 2001). For this reason, genetic tests were developed in order to distinguish *Spartina* species (Ayres et al. 2008). Traditionally, the most common physical features used to differentiate pure *S. foliosa* from *Spartina alterniflora* and its hybrids were relative height, culm color, and culm width (Callaway and Josselyn 1992, Zaremba 2001, Ayres et al. 2004). Early genetic research using RAPDs determined culm color and culm width as the best predictors of hybridity (Ayres et al. 2004). In terms of culm coloration, hybrid *Spartina* can often have a pink to dark burgundy coloration at the base of the stem as contrasted with the green of native *Spartina* (Ayres et al. 2004). Thicker culms also seem to correlate with hybrid *Spartina* genetic identity (Ayres et al. 2004). When present, these features are useful in identification of hybrid *Spartina*, but they are less useful as a means of identifying cryptic hybrids, which may contain hybrid *Spartina* genetic material but do not display the morphological characteristics associated with hybrid *Spartina* (Hogle 2011a). As the more obvious hybrid *Spartina* clones have been treated, project staff have needed to examine less obvious characters to identify the remaining hybrid. These characters are not necessarily definitive in determining hybridity; rather, they are clues to hybrid presence. The features that the Invasive *Spartina* Project most often use are itemized below, with literature justification where possible. Note that the below list includes papers that compared *S. foliosa* and *Spartina alterniflora* in addition to comparisons between *S. foliosa* and hybrid *Spartina*.

In terms of general vegetative structure, many features are used to predict hybridity. They include:

1. Plant Posture: Thick, stiff stems enable hybrid *Spartina* to accrete sediment rapidly. (Grosholz et al. 2009) This can result in hybridized *Spartina* having a degree of leaf and stem stiffness not typically exhibited by *S. foliosa*. The result of this characteristic is a plant that looks obviously rigid and spiky.

2. Leaf Angle: The above mentioned leaf stiffness often results in hybrid *Spartina* having acutely angled leaf blades.

3. Leaf Width/Length: *Alterniflora Spartina* can produce greater biomass than *S. foliosa* (Callaway and Josselyn 1992). This sometimes presents itself as wider and longer leaves than *S. foliosa*.

4. Rhizome: *S. foliosa* is more shallowly rooted with a thinner taproot than hybrid *Spartina (Grosholz et al. 2009).*

5. Culm Density: *Alterniflora* and hybrid *Spartina* can exhibit a greater culm density than *S. foliosa*.

6. Green-late: Hybrid *Spartina* and *Spartina alterniflora* can senesce much later than *S. foliosa*. Thus, late chlorophyll presence can indicate hybrid (Callaway and Josselyn 1992).

7. Early Growth: Hybrid *Spartina* has been found to initiate growth up to one month earlier than *S. foliosa* (Callaway and Josselyn 1992).

In terms of inflorescence characteristics, hybrid *Spartina* is a superior competitor to *S. foliosa*.

1. Hybrid *Spartina* can flower both earlier and later within a given season than *S. foliosa.* (Anttila et al. 1998, Ayres et al. 2008)

2. Hybrid *Spartina* also can have a longer inflorescence with more seeds than *S. foliosa* (Anttila et al. 1998).

Other characters used derive from knowledge of a site's history. These are much more subjective and are important considerations while working in the field, but have not necessarily been academically documented. All were presented in Stalker et al. 2011.

1. Historic Presence: ISP has nine years of data on hybrid presence. Staff use past data to inform current decisions.

2. Proximity to Hybrid: Hybrid *Spartina* has greater pollen and seed set than *S. foliosa*. Staff are more suspicious of plants that are close to current hybrid populations.

3. Treatment History: Treatment of *Spartina* can weaken hybrid, which may cause it to look morphologically similar to native *S. foliosa*.

4. New *Spartina* Population: *Spartina* found in a new location within a site (e.g., appearing on a riprap shoreline where it did not previously grow) is suspect.

Morphological differences in *S. foliosa* and *Spartina alterniflora* hybrid contribute to different fauna associations. In 1997, Daehler and Strong noted that native cordgrass is shorter, has shallower roots, and grows less densely than its hybridized counterpart. Hybrid *Spartina*'s dense root structure and rapid growth allows this species to rapidly accrete sediment, modifying marsh habitat. *Spartina foliosa*, by contrast, is only a minor ecosystem modifier (Strong and Ayers 2009). Differences in plant structure resulted in differences in invertebrate communities between hybrid *Spartina* and *S. foliosa* marshes. (Neira et al. 2007) found that while hybrid *Spartina* invasions less than 5 years old supported roughly the same number and diversity of invertebrates as native marshes, invasions of hybrid *Spartina* that were older dramatically declined in invertebrate diversity in all areas except the leading edge of the invasion. Pure stands of native *S. foliosa* consistently supported more invertebrates in terms of both diversity and number. The magnitude of this varied, but stands of *S. foliosa* could be as much as 5 times more diverse than their hybridized counterparts (Grossholz et al. 2009). Hybrid stands also varied in benthic species composition. While *S. foliosa* marshes had a higher proportion of surface feeding invertebrates, hybrid marshes had more subsurface feeding invertebrates in absolute terms. This may have consequences for higher trophic levels as surface feeding invertebrates tend to be larger than subsurface feeders and act as a more readily available prey source (Grosholz et al. 2009).

RESTORATION OF *SPARTINA FOLIOSA*

SOUTHERN CALIFORNIA

Most of the research that has been done on *S. foliosa* restoration has been done in Southern California marshes. Southern California has lost over 90 percent of its salt marsh habitat; many former shorelines are filled, developed, and highly urbanized. This results in limitations on the area in which wetland restoration may occur. Thus, San Diego restoration projects often seek to remodel existing wetlands to offer greater "value" rather than attempting to create new habitat. As a consequence, most of the completed restoration projects in this area have involved turning upland or seasonally closed lagoons into tidal salt marsh habitat (Zedler 1996, Zedler et al. 1999).

Much of the restoration work in San Diego is aimed at restoring habitat specifically for the highly endangered light footed clapper rail. This bird has shown a preference for tall, dense *S. foliosa*. Thus, restoration efforts in San Diego have been aimed at restoring the tall growth form of *S. foliosa* to newly modified areas. Restoration marshes tend to have less nutrients and organic matter than their natural counterparts. *S. foliosa* transplants survive in these conditions, but are not tall enough to support nesting of the light footed clapper rail (Zedler 1993). The desire for tall *S. foliosa* coupled with the effects of poor soil sediment nutrition led to several nitrogen fertilization studies. Researchers have found that found that although addition of nitrogen seasonally increased plant height, no treatment effect remained the following year. This research concluded that nitrogen addition is not a suitable way to promote tall *S. foliosa* growth (Boyer and Zedler 1998). Another study looked at the effects that roto-tilling kelp into dredge sediment had on *S. foliosa* survival and growth. This research found that although kelp did not change sediment organic matter, *S. foliosa* plugs transplanted into this modified substrate were taller and had denser culm growth. This is because kelp acted as a nutrient source (O'Brien and Zedler 2006).

Research in Southern California has also looked at potential effects of the *S. foliosa* donor population. Due to the high salinity of southern California marshes, many *S. foliosa* stands tend to have low seed viability (Trnka and Zedler 2000, Sullivan and Zedler 2001, O'Brien and Zedler 2006) and restoration by seed has not been successful; thus, plug transport is most commonly used. In 2000, Trnka and Zedler found that the short growth form *of S. foliosa* found in San Diego County was caused by conditions (high salinity, low nitrogen) and not genotype. This research looked at different morphologies of *S. foliosa* within the same marsh, and did not test differences in morphologies across marshes. However, knowing that short form *S. foliosa* transplants can be used to yield tall form transplants has proven beneficial. Restoration practitioners do not need to gather ramets from tall *S. foliosa* marshes in order to produce tall *S. foliosa* plugs. They can instead gather ramets from low cover, poor clapper rail habitat. More specifics on plug based restoration are discussed in the Methods of Restoration section.

A restoration project (8ha) in the Tijuana Estuary in San Diego tested how proximity to channel, nitrogen level, and planting density affected *S. foliosa* survivorship and growth. This restoration project planted 6300 *S. foliosa* plugs and had roughly 4700 plugs surviving after 2 years. Plots in which kelp compost had been rototilled into marsh sediment had the highest density of *Spartina* culms (47% more stems) and the tallest heights (11cm taller on average) of any *S. foliosa* treatment. Counter to researchers' hypotheses, no positive correlation was found between proximity to channels and survivorship (Obrien and Zedler 2006). This relatively successful experiment followed several years of failed restoration efforts in this restoration site. Due to issues with construction and weather, this restored site had poor sediment and hyper-saline conditions prior to initial plantings. In 2000, roughly 4000 marsh halophyte seedlings were planted at this site. Most of these plants died within the first year. Adaptive management was a key to later successes within this marsh (Callaway and Zedler 2009).

San Francisco Bay

San Francisco Bay marshes differ from Southern California marshes in hydrology, salinity, and precipitation (Callaway et al. 2009). This may mean that restoration techniques and issues from San Diego will not necessarily be applicable to problems found in San Francisco Bay tidal marshes. For example, *S. foliosa* in southern California has low seed viability (Zedler 1982); however, research in northern California has shown success with germinating *S. foliosa* for the purpose of planting in the newly created marsh (Newcombe et al. 1975). Additionally, *S. foliosa* in San Francisco Bay may not be as nitrogen-limited as are Southern California populations. Tyler (2007) found that adding nitrogen to *S. foliosa* had no effect on culm density, culm height, or biomass. This followed Army Corps of Engineer experiments from the 1970s, in which researchers noted that nutrient additions to *S. foliosa* plantings did not play a significant role in plant survival or growth (Newcombe et al. 1975). A further difference is in that of recruitment limitations. Ward (2003) found that *S. foliosa* only colonized accreted mudflats during unusually wet years. However, several restoration projects in the San Francisco Bay have seen continual recruitment of *S. foliosa* once appropriate elevations have been reached (William and Faber 2005: USGS in press).

Within the San Francisco Bay itself, marshes are highly variable in terms of sediment properties and hydrology. This is potentially because the southern portion of the bay tends to function as a "lagoon" while the northern portion of the bay acts more like a traditional estuary (Atwater et al, 1979). In terms of marsh dynamics, the marshes of the North Bay are much older than the south bay marshes. This might result in marshes with different sediment and hydrological properties (Atwater et al. 1979, Watson 2008b). For example, a marsh in the far south bay, Calaveras, has been observed to expand dramatically in size with the past 20 years (Watson 2008a). However, during this same time Muzzi Marsh in Marin has been contracting (Faber pers comm. 2010). These differences can also be noted in vegetation: (Cuneo 1987) found that *S. foliosa* is an order of magnitude more common in the South San Francisco Bay than in San Pablo Bay.

The San Francisco Bay is unique from Southern California in two additional ways. First, areas formerly invaded by hybrid *Spartina* have been hydrologically and chemically altered by the invasion. This hybrid plant raised marsh elevations, altered soil properties, and increased organic material. Grossholz (2009) suggests that the decay of below ground biomass and the resulting sulfide and anoxia may slow the natural revegetation processes in some marshes. The modified marshes may persist at raised elevations due to the aforementioned rootmass. Removal of hybrid may also lead to hyper-salinity in areas that did not naturally revegetate. The pattern of denuding leading to high salinity is well documented in both southern California and the Eastern United States. Secondly, restoration in the San Francisco Bay is taking place on a much larger scale than that in Southern California. In the coming decades, restoration projects will continue to transform over 24,000 ha of diked land to tidal marsh (Goals Project 1999). Thus, methods employed in San Diego may not be practical for San Francisco Bay.

Only smaller scale *S. foliosa* restoration has been attempted in the San Francisco Bay since the late 1980s. This is partly because of the limited success of some restoration efforts (Race 1985, Williams and Faber 2001), and partly because natural recruitment of *S. foliosa* was occurring without large scale planting efforts (Williams and Faber 2001). Additionally, in sites near the hybrid *Spartina* invasion, best marsh practices have advised against *S. foliosa* planting (Invasive Spartina Project 2010). That being said, there is a large body of research work on *S. foliosa* restoration resulting from both smaller scale projects and the larger scale Army Corps projects of the 1970s. This research is found in the form of government documents, reports, and unpublished theses.

Crispin (1976) had success germinating *S. foliosa* within a growth chamber setting. He found that plants germinated the best after being stored at cold temperatures in brackish for 135 days. He also found that plants germinated better at warmer temperatures (20 degrees Celsius). Yet despite his success in germination in the growth chamber and greenhouse, Crispin was unable to produce high germination rates in field plantings. Only 35 of 1000 seeds used in a field experiment germinated. (Greer 1998) had a higher success rate of germination in the field, but low seedling survivorship. Only 9 out of 1650 seedlings survived for an entire field season. Army Corps of Engineers studies reflect this same trend. While the plants germinated at higher rates in greenhouse settings, only one percent of seeds planted in dredge spoils developed into mature plants (Floyd and Newcombe 1976).

As in San Diego, research has looked at the effect donor ecotype has on transplant success of *S. foliosa* in dredge spoils in the South Bay. A short (dwarf) form of *S. foliosa* was found to have higher rate of survival and higher stem production than robust *foliosa*. However, dwarf *foliosa* remained shorter than the most robust plantings at lower elevations. At mid-elevation marsh, survivorship of robust *foliosa* decreased rapidly, and dwarf form had a 40 percent higher survival rate than tall form (Harvey 1975). However, a later common garden experiment suggested that dwarf *foliosa* and robust *foliosa* would grow to the same heights if grown in a common garden (Cain and Harvey 1983).

Several larger scale *S. foliosa* projects were attempted from the 1960s to the 1980s. During this era, *S. foliosa* planting success was used as the metric by which mitigation success was measured (Williams and Faber 2001). This means that in order for a mitigation project to be declared successful, it needed to be vegetated to a certain percent. Projects in East Palo Alto by H.T Harvey and Associates and in Fremont by the Army Corps of Engineers (Newcombe et al. 1975, Cain and Harvey 1983) both demonstrated that Pacific Cordgrass could be transplanted. However, other projects (see below for description of planting methods used on known projects within the San Francisco Bay) were less successful. In fact, Race (1985) wrote a critical review of *S. foliosa* restoration projects which called into question the success of these mitigation projects. She asserted that 90 percent of *Spartina* plantings had died out within the first 2 years of planting. This journal article was refuted by (Harvey and Josselyn 1986), who said that Race had misidentified experimental plantings as equivalent to restoration. During this same time, it was noted that *S. foliosa* naturally colonized most restoration sites through natural seeding. The combination of these factors combined to deter *S. foliosa* plantings in the bay. Thus, popular practice for last 2 decades has been to allow *S. foliosa* to passively recruit (Race 1985, Williams and Faber 2001).

Relevant information from specific restoration projects in San Francisco Bay estuary is provided in the following sections.

Faber Tract: East Palo Alto, CA

Years 1971-1974

Levees were placed around the Faber tract in 1935 in order to convert marsh to pasture land. Between 1961 and 1963, these levees began to erode and muted tidal action was allowed in the site. In 1968-1969, dredge spoils from Palo Alto Harbor were deposited on the tract. On July 15, 1971, the Faber tract was opened to tidal action, and one week later 441 plugs of *S. foliosa* were planted on an elevation transect within the site. No published study resulted from this work. However, HT Harvey (1989) detailed his personal observations of the plantings in a memo to the US Fish and Wildlife Service, stating that: 1) Cordgrass planted above mean high water died. 2) Pickleweed at this site did not seem to hinder cordgrass growth. Based on H.T. Harvey's personal notes, it seems the site had a 57 percent survival rate of plugs.

Grand Avenue Overpass: Oakland, CA

Years: 1969-1971

This was an experimental planting that used *S. foliosa* plug plantings. The results of these plantings are contradictory in the literature. Race (1985) states that 10 percent of plugs survived. However, Harvey and Josselyn (1986) reiterate the experimental nature of the plantings and say that Race misrepresented this research. This research was completed by the now defunct Madrone Associates.

Alameda Flood Control Channel: Fremont, CA

Years: 1973-1976

This was a large scale study funded by the Army Corps of Engineers which looked at the suitability of dredge spoil materials for marsh creation. The focal area of this study was a former salt pond connected to the main flood control channel. A stated goal of this project was to learn as much as possible about the artificial propagation of *S. foliosa* and *Sarcocornia pacifica* (Mason 1973). Thus, this study looked at the survival of *S. foliosa* plantings from cutting, seed, and plugs. Growth form (tall versus short) and nutrient supplementation were also researched. Data on survival was collected 6 months and 18 months after initial planting. The authors had high survivorship (greater than fifty percent) of most treatment types. Seeds had a one percent germination rate; however, seeding was less labor intensive. The lowest survivorship vegetative plantings were from cuttings of tall growth form *S. foliosa*. The highest survivorship was from dwarf form plug plantings. The authors suggest that the seeding method would be the least time consuming method for a large scale project (Newcombe et al. 1975). However, the aforementioned study makes no mention of the possibility of natural recruitment. A further note, this project is generally regarded as the project that brought Spatina *alterniflora* to the San Francisco Bay. While researchers in these texts do mention collection techniques, storage methods, and germination rates of *S. foliosa*, it is unclear in the texts as to when the *S. alterniflora* seed was planted at these field sites.

A more detailed description of the plug and seeding methods is found under the restoration experience section.

US Army Corp of Engineers Bank Erosion Control Projects

Years: 1975-1979

Locations: Point Pinole, San Mateo, and Alameda Creek.

A group of three projects fall under the umbrella of an Army Corps of Engineers project which looked at the feasibility of using intertidal marsh vegetation to control erosion on the open shores of the San Francisco Bay system (sites with high wave action). Stated goals were to develop techniques for propagating, transplanting, and maintaining plants for shoreline erosion abatement. Field plantings were done using seeds, sprigs, plugs, and bioconstructs (cordgrass plugs attached to ribbed mussels). This study was done for the express purpose of planting *Spartina* in high wake zones that did not necessarily already support *S. foliosa*; thus, these plantings should be viewed as highly experimental. The highest survivorship of planted plugs in this experiment were planted a kilometer up a tidal slough. The majority of these plantings that survived were plugs that were harvested from a mussel-cordgrass community. Researchers termed these plugs "bioconstructs." Most of the plugs planted in high wave action zones did not survive. (Newcombe 1979).

In addition to plug planting, researchers also attempted seed restoration areas. Both the San Mateo site and the Alameda Creek site were seeded. The San Mateo site was hydroseeded (seeds applied by water hose) with 150 liters of seed. Researchers commented that this process seemed to tear embryos from their hulls. The Alameda Creek site was hand seeded and the seeds were raked into sediment. Neither method led to any *Spartina* establishment. Plugs had higher survivorship than sprigs, but did not establish on any exposed sites (Newcombe 1979).

Marin Country Day School

Years: 1974-1976

This restoration project was undertaken as a mitigation for lost marsh resulting from the building of the larkspur ferry terminal. 594 plugs of *S. foliosa* were planted on an area of 467.3 m^2 in Corte Madera, California. The objective of this project was to retard erosion. Plugs were transplanted from the nearby Larkspur Ferry Terminal site and placed at 3-m intervals in a strip 9.15 m wide (30 ft) along 76.2 m (250 ft) of shoreline. Qualitative monitoring for survival was done from the time of planting in May 1974 to September 1975, at which time 235 of the original 594 plugs remained. Remaining vegetation was reported to be similar to nearby marsh. However it was concluded that *S. foliosa* was not as effective at erosion prevention as *S. alterniflora* (Race 1985, Harvey 1986, Goodwin 1991). The original report is from the now defunct Madrone and Associates.

Anza Pacifica lagoon

Years: 1974-1978

This was a mitigation project that mandated planting at the edge of this lagoon. In 1974, four edge areas of the lagoon were each planted with 125 *Spartina* plugs, seedlings, or cuttings, and 1 liter of seeds. All plots failed. In June 1978, replanting was tried with 448 plugs divided over six plots (Harvey 1983). After 18 months, less than a third of the original cordgrass plugs remained (Harvey 1979). By 1981, all that remained of the plantings were sparse remnant patches of plugs at three locations in the lagoon.

Crissy Field

Years: 1999-present

Crissy Marsh is located in the Golden Gate National Recreation Area's Presidio in San Francisco. This historic wetland had been diked and filled beginning in the late 1800s. The final fill occurred by the U.S. Army in 1915 for use in the Panama-Pacific International Exposition (Ward et al 2007). In the 1990s, a plan was formed to restore this wetland and plant it with wetland plants. This marsh was excavated and *S. foliosa* from brickyard cove in Marin, CA was planted in this site. *Spartina foliosa* survived but did not rapidly expand (Ward pers. comm. 2010). Within 19 months of tidal reconnection, Crissy field became impounded due to sediment deposition. More than 22 intermittent closures have occurred to date. Native cordgrass has suffered due to these closures, and cordgrass at this site persists, but has not rapidly expanded (Ward pers. comm. 2010).

Restoration of *Spartina alterniflora*

There is much literature related to *Spartina alterniflora* (smooth cordgrass) restoration on the East Coast and Gulf sides of the United States. There is also a rather large body of work related to marsh reclamation of *S. alterniflora* in China. This east coast foundation species is a closely related congener of *S. foliosa*. However, it is more genetically diverse and is a much more adept ecosystem builder than *S. foliosa*. It spreads quickly by rhizome, and tolerates a wide range of salinity and soil conditions (Strong and Ayres 2009). However, much like *S. foliosa*, *Spartina alterniflora* has reduced fertility when self-pollinated and seedling recruitment is generally limited to bare substrate (Somers and Grant 1981, Metcalfe et al. 1986).

Much research has been done on the east coast on the clonal behavior of *Spartina alterniflora*. Clonal plants fall into two distinct categories based on their seed dispersal capabilities: 1) Clones with large seeds adapted for germinating in established populations, known as repeated seedling recruiters. 2) Clones with small seeds adapted for long-range dispersal and colonization of novel environments, known as initial seedling recruiters (Eriksson and Bremer 1993). Travis (2004) found that diversity of Atlantic cordgrass genetics tended to decrease with age, suggesting that Atlantic cordgrass is the second type of clone species. Some researchers have noted that this type of clonal species tends to decline in diversity over time as founding populations experience mortality or are outcompeted. This has implications for restoration, as Atlantic cordgrass marshes are generally founded from a small number of clones and thus will peak at very low levels of clonal diversity. Small mortality events could result in genetic monoculture. This explains why there is a decline in clonal diversity beyond a marsh age of 30 years, and a lack of seedling recruitment in established smooth cordgrass populations (Travis et al. 2002, Proffitt et al. 2003, Travis et al. 2004). A later study using microsatellite markers verified the lack of diversity in one subset of marshes in New York (Novy et al. 2008).

Several experiments have tested the effect of donor population on site restoration for *Spartina alterniflora* (Proffitt et al. 2003). In a common garden, several morphologies of *Spartina alterniflora* were planted and measured for survival and growth over a period of 18 months. Mortality as a result of transplantation shock varied significantly among clones and was directly related to differences in clone growth form. One clone was better at achieving rapid lateral growth at all elevations. Clones exhibiting the highest stem densities had the shortest mean stem heights, while the sparser clones tended to be taller. The authors' conclusions were that the common garden highlighted structural heterogeneity and that plant materials are more successful if donor populations happen to be preadapted to the restoration site, which may be a simple matter of physical proximity (Gallagher et al. 1988; Travis et al. 2006). However, another study in which plants were continually grown in a common garden showed that parental effects dissipated after three years of monitoring (Thompson 1991). Insight into planting methods *S. alterniflora* are included below in the methods of restoration section.

Methods of Restoration

Listed below are various techniques of restoration that have been used on either *Spartina* species or submerged aquatic vegetation. Before a more detailed outline is given, a few general points will be made about donor populations and donor site selection as related to restoration success.

First, *S. foliosa* has been observed to quickly recruit to newly breached tidal areas, especially areas that are not near large invasion sites. In restoration areas such as Carl's Marsh in Petaluma and Muzzi Marsh in Corte Madera, recruitment by *S. foliosa* was noted to occur within 4 years of initial tidal breaching (Faber 2004, Tuxen et al. 2008). However, restoration success may be lower in marshes that are not near native stands of *S. foliosa*. A recent study that looked at seed rain in restoration marshes in the San Francisco Bay found that when vegetation is not present at nearby reference marshes, the species is noticeably missing from the seed rain as well. Notably, in this study, the site's reference marsh did support *S. foliosa,* and *S. foliosa* did recruit (Diggory and Parker 2010). San Diego Bay restoration research found that the most common recruiters to newly open tidal marsh zones were exotics, and that, in salt marshes that were open for 5 years, well over 50 percent of new seedlings were *Sacrocornia pacifica*. In more established marshes, the most frequent colonizer was the native abundant *Triglochin cocinna*. This study implies that new restoration marshes largely recruit invasive or common species (Morzaria-Luna and Zedler 2007).

Lesica and Allendorf (1999) suggest that the short and long term success of any vegetative restoration project may be dependent on choosing the right source material for this project. They give these general guidelines for choosing restoration material:

1) Avoid using strongly selected for cultivars.

2) Initiate new populations of a given species with as many genotypes as possible (including as much genetic variation as possible). This is especially important when disturbances have been severe.

3) Use local genotypes when possible, especially for large sites.

4) Use phenotypically plastic species with wide ecological amplitude.

5) Use selfing species or those with low dispersal capacities to avoid genetic contamination of nearby populations (Lesica and Allendorf 1999).

Site selection within the San Francisco Bay may be limited by hybrid presence. Researchers have found that *S. foliosa* inflorescences can be contaminated by hybrid *Spartina* (Anttila et al. 1998). The effect of *Spartina alterniflora* pollen dissipates with distance. *Spartina alterniflora* researchers within Willapa Bay, Washington, found that *Spartina alterniflora* pollen amount decreased by an average of 85 percent across a 100-meter-wide channel on the downwind side of the meadow (Davis et al. 2004a, Davis et al. 2004b). Due to this finding, an Invasive *Spartina* Project publication entitled "Best Practices for Marsh Restoration" suggests that *S. foliosa* restoration projects should be undertaken at a minimum of 100 meters from non-native *Spartina.*

PLUGS/SODS

This the most common technique used to restore *S. foliosa*, and it is generally employed with high success. A recent planting of 6000 plants in San Diego had less than a 25% mortality rate (O'Brien and Zedler 2006). For this method, a sod of *S. foliosa* is collected from a salt marsh. This sod is either immediately planted or collected and allowed to grow prior to harvest. If plants are collected and immediately planted, they should be collected from sites with harsher conditions than those at the transplant site. If this is not possible plants can be treated in order to harden them to salinity (Trnka and Zedler 2000). Plants propagate well from plugs three to six inches wide in diameter with rooted shoots. Larger blocks should be broken up just prior to planting. The roots of the plants should not be allowed to dry out. Sprig planting involves a similar methodology, but only one rhizome is planted. This was found to be largely unsuccessful (Mason 1973).

In a memo prepared for the Invasive *Spartina* Project in 2006, PHD botanist Peter Baye gives specific recommendations on how to restore *S. foliosa* to areas affected by hybrid *Spartina*.

He recommends the use of sod plugs or individual shoot clusters in restoration. Sod plugs are more resilient and mechanically stable than bare-root sprigs (shoot clusters). However, collection of wild-grown plugs is more labor-intensive than harvest and transplanting of sprigs.

As an additional consideration, areas from which to harvest pure Pacific cordgrass in the South Bay are limited. However, like Lesica and Allendorf (2009), Baye advises collecting multiple genotypes of Pacific cordgrass to allow for adequate outcrossing and relatively high seed set.

As a future caution, wild-grown plugs should be genetically tested for hybridity if collected from remnant native clonal stands in the South Bay.

In terms of specifics of planting design, Baye suggests that planting intensities can emulate natural patterns of colonization. While stabilization plantings require planting as a continuous zone of minimal width and density, founder populations of Pacific cordgrass generally consist of scattered, small colonies. This means that one Pacific cordgrass colony per 100 to 200 m of marsh/mudflat edge or channel bank is reasonable as a founder colony density. These "founder colonies" should consist of 5 to 10 sprigs of transplants, with at least two (presumed) distinct genotypes per founder colony. These sprigs can be spaced at least 0.5 m apart. The plantings can then be fortified with amendments such as coarse, non-buoyant "mulch" on the mud surface (such as oyster shells or gravel) around the sprig's base, which should help prevent washouts in less sheltered positions.

PLUGS WITH BIOCONSTRUCTS

In the 1979 Army Corps of Engineers Study, they determined that the most successful plantings were those using plugs harvested from a mussel-cordgrass community. These "bioconstructs" had high survivorship in a high wave action site. Race (1985) is highly critical of this conclusion. She comments that successful plots were either established within existing cordgrass-mussel community or within a creek (not on the outer banks of marsh exposed to the bay). In fact the plots furthest up the creek were the healthiest in terms of growth and survivorship. Bayward, the bioconstructs produced less robust *S. foliosa*. She also comments that these results had not been replicated. However, east coast research confirms that mussels may have a positive effect on cordgrass growth. By experimentally removing and adding mussels, Bertness (1984) demonstrated that mussels stimulate aboveground and belowground *S. alterniflora* production*,* finding that mussel density is positively correlated with increased cordgrass height, biomass, and flowering.

SEEDS

Sullivan (2001) notes that there are two distinct advantages of using seeds in a coastal wetland restoration project:

1) Plants grown from seed will likely be more diverse than plants brought to a site via plugs.

2) Collecting seed stock rather than plugs minimizes impact on marshes.

While the benefits of seed based restoration are clear, researches have not always been able to capitalize on seed based restoration for *S. foliosa*. Researchers in southern California have noted the low rates of native cordgrass germination and tend to not use this method in restoration projects (Trnka and Zedler 2000). Seed viability of *S. foliosa* seems to vary widely between years for a large range of reasons. However, one concern in collecting seed is the fungal pathogen ergot (*Claviceps* sp) that can nearly eliminate seed production in any given year. This fungus seems to disproportionately affect the outer north coast marshes of San Francisco Bay (Fisher et al. 2005).

However, several small scale projects have attempted to germinate *S. foliosa*. While a few of these projects have aimed at restoration, many of the other projects sought to germinate seeds on a small scale in order to answer questions of hybrid *Spartina* performance compared to *S. foliosa* performance. Below is a description of two unpublished master theses that looked at *S. foliosa* germination and seedling survival. This is followed by a description of techniques used for germination in genetic experiments lab. After this, the document will quickly relate how this compares to methods of seed based restoration of *Spartina alterniflora* on the East Coast.

A key concern in using seed based restoration is that *S. foliosa* seeds seem to have a dormancy period. Crispin (1976) found that plants stored in one percent instant ocean solution at 4.4 degrees Celsius had an 84 percent germination rate after 135 days. However, only two percent of seeds germinated with no cold storage period. Crispin attempted to rupture seed hulls in order to forgo the dormancy period. However, this only increased the germination rate to 9 percent. Crispin also looked at the effect temperature had on germination rate. Germination was the highest when temperatures fluctuated between 18.3 degrees Celsius and 26.6 degrees Celsius and germination rates were second highest when temperature was held constant at 20 degrees Celsius. At both higher and lower temperatures, germination success decreased. Increasing salinity also significantly decreased germination ability. At ideal temperatures and storage, over 70 percent of *S. foliosa* seeds germinated in fresh water. At 2 percent salinity, germination was only 30 percent.

While all the aforementioned studies were performed in a growth chamber, Crispin also looked at the effect planting depth had on germination and emergence in both the greenhouse and the field. In the greenhouse, he determined that a half of centimeter sediment cover reduced plant emergence by 72.5 percent and one centimeter of sediment reduced emergence by 88.7 percent. For the most part, these seeds did germinate, but they did not emerge from the sediment within 40 days.

In the field, this researcher placed germinated seeds and ungerminated seeds in burlap bags parallel to the shoreline. For both treatments, few seedlings (18 and 17 out of 500) were present after 40 days. Crispin postulated that the burlap provided too much of a barrier to germination.

For all the studies mentioned, Crispin presorted *Spartina* seeds by candling and only used seeds that looked fertile.

A later research project looked more in depth at field plantings and survivorship. Greer (1998) followed the same methods of cold storage and candling for seeds. He also validated his sorting technique via tetrazolium tests which suggested about 90 percent viability of sorted seed. Greer directly planted seeds into Bolinas lagoon at 3 different depths. Out of 1650 seeds planted, a total of 301 seedlings germinated (18.2 percent). No significant effects of planting depth were noted. However, Greer did suggest that while *S. foliosa* planted at 12.5mm tended to germinate more, seeds that were planted at 26.3mm tended to have higher survivorship. He also found that plants germinating from deeper sediment tended to have a higher culm number. It may be worth noting that that Greer was unable to use seed from Bolinas lagoon in his field experiments. He found that seeds from this outer coast site were highly damaged by ergot. He instead used seed from Muzzi Marsh in Marin.

While Greer had better germination rates than Crispin in field experiments, he had poor survivorship of germinated plants. Only 9 seedlings survived until October (following a February planting). He blamed the majority of mortality on algal colonization.

The Army Corps of Engineer experiments also had limited success with seed based plantings. Mason (1973) collected seeds in mid-October. This may have been late in terms of timing. He only found viable, undropped seeds in northern San Francisco Bay marshes. Most *S. foliosa* marshes had already dropped seed. He collected seed via boat with a three-man crew. One person operated the boat, one person pulled culms over the boat, and one person clipped inflorescences with hedge shears. Inflorescences were then placed in salt water for 2 weeks after which time they were put under a hose in order to break chaff. Seeds were then stored at a cool temperature (40 degrees F) in salt water to retain viability prior to germination. At least 2 months of storage time was needed to allow for an after-ripening before germination. This after-ripening time can be sped up, according to Mason, by soaking seeds in fresh water for two weeks. However, Sullivan and Noe (2001) caution that results comparing germination in fresh and salt water have not been consistent. These authors also recommend collecting seeds at shattering, just as mature seed is shedding. The authors think that this might prevent losses from herbivory. They also recommend multiple collection dates to assure mature seed collection.

Much of seed germination information was borrowed from East Coast *Spartina alterniflora* research. Germination of this plant has been studied over the past 3 decades. In order to collect *S. alterniflora*, authors recommend that researchers gently shake inflorescences in order to collect only seeds that are fully mature and ready to drop. Collected seeds should be cleaned of foreign materials prior to being kept in moist, wet storage to break dormancy (Bieber and Cadwell 2008). This is because *S. foliosa* and *Spartina alterniflora* caryopses require a moist chilling period (approximately six weeks) prior to germination. *Spartina alterniflora* seed is recalcitrant and, therefore, cannot be dried to 10–15 percent moisture content for long-term storage. It must be stored at 100 percent moisture (Uzomo et al. 2009).

Seed viability is short-lived (roughly 8 months); therefore this species does not maintain a persistent seed bank. Although *S. alterniflora* appears to produce a significant number of seeds, most spikelets are empty, or contain a damaged or sterile caryopsis (Bierber and Cadwell 2008).

If seedlings could be germinated in a greenhouse setting, S. foliosa seedlings may be able to be transplanted directly from flats as either part of a sod block, as a cube cut from a flat, or within peat pots. All of these methods have been employed on other halophyte species in southern California (Sullivan 2001).

Eelgrass Restoration Techniques

Horizontal Rhizome: This method involves collected ramets from donor marshes. The rhizomes of two eelgrass shoots are overlapped in opposite directions and secured horizontally into sediment with a bamboo staple (Davis and Short 1997).

Bamboo Stake: This method also involves using collected ramets from donor populations. However, this technique may potentially require a taller plant. In this technique, rhizomes are secured to a bamboo stake using a loose burlap bind. The top of the plant is then connected to the bamboo by a wire, and the bamboo stake is placed 20 cm deep in the substrate (Boyer and Carr 2008).

ADDITIONAL PLANTING CONCERNS

AGE

Plants can be transplanted at any age from seedling to mature. Larger plants will have a more developed root system and canopy which may help to buffer against transplant shock. However, larger plants take a longer time to grow, require more handling, and can limit the restoration process. Small plants will require few resources, but may have lower survivorship.

ELEMENT EXPOSURE

Another key concern in planting is salt hardening. Salt tolerance in halophytes needs to be induced so plants are slowly conditioned to insure that they are not shocked upon planting. Sullivan (2001) recommends watering plants with a 1 to 8 dilution of seawater to freshwater which increases 4 to 6 ppt each day. Plants should be hardened to withstand 35 ppt. In hypersaline sites, irrigation may be required. Plants grown in shade may also require sun hardening.

PLANTING TIMING

Spartina foliosa establishes best in gaps of low salinity during wet years. This varies year to year. It is best to have extra material in case of unpredictable weather (Sullivan 2001). Baye (2006), in his memo to ISP, suggests that cordgrass transplanting should occur when *S. foliosa* stems are just beginning to elongate, but before new roots elongate significantly. This stage usually occurs in March to early April. Transplants can be made during the growing season, but transplanted shoots generally die back and regenerate from tillers.

MONITORING

Prior to restoration certain physical characteristics of a site should be monitored. Elevation of the plantings should be considered and hydrology should be assessed. Soil cores should be taken at each location in order to assess soil salinity, bulk density, nitrogen level, sediment composition, and sediment grain size. If it is a new restoration site, baseline flora and fauna surveys should be performed (Zedler and Callaway 2008).

After growing seasons, survival, growth (number of culms, etc.) should be measured. Soil cores should be taken a second time order to determine if conditions have changed. Plants could be randomly harvested in order to compare below ground biomass. However, combined culm height is a good proxy for total biomass (Boyer et al. 2000).

RECOMMENDATIONS FOR MONITORING/EVALUATING RESTORATION PROJECTS

Restoration can be defined as "returning an ecosystem to a close approximation of its conditions prior to disturbance. Accomplishing restoration means ensuring that ecosystem structure and function are recreated or repaired and that natural dynamic ecosystem processes are operating effectively again." (Ecosystems--Science et al. 1992).

(From Zedler and Callaway 2000)

1) Do not use the terms failure and success. Use the term progress.
2) Many parameters should be measured at restoration sites, including: salinity in first 10cm of soil, topology, hydrology, total soil nitrogen, soil organic matter, soil texture, and other organisms present.
3) The monitoring record should be evaluated and interpreted as the data are collected.
4) Research program should be integrated into the assessment program to identify and explain problems and predict if and when restoration goals might be reached.

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Proposed Conservation Measures for Revegetation Activities Associated with the San Francisco Estuary Invasive Spartina Project California Clapper Rail Habitat Enhancement, Restoration, and Monitoring Plan

The Conservancy proposes to implement the following measures during revegetation planting, monitoring, and maintenance activities to help protect sensitive species, including California clapper rail, salt marsh harvest mouse, western snowy plover, and California least tern.

Conservation Measures for all work in the marsh:

1. **Minimize disturbance**. While traversing through the marsh, noise will be kept to a minimum. Workers will avoid using multiple pathways through the marsh, and will use berms, boardwalks, or roads if they exist. Routes will be planned and mapped prior to entry in the marsh to minimize time spent in the marsh and to decrease chance of running into hazards/barriers such as large channels. Workers will be observant of their environment to minimize disturbance.
2. **Avoid potential nesting habita**t. Workers will avoid traversing through thick vegetation or areas where the ground is not visible, as well as thick wrack areas where salt marsh harvest mice may nest. Workers will be trained to identify suitable California clapper rail nesting substrate, and will minimize disturbance of these areas (e.g., stands of and tall pickleweed).
3. **Crossing channels**. When looking for a suitable place to cross a channel, such as an area of sparse vegetation, workers will avoid traveling along the edge of the channel/slough because these areas provide nesting habitat for California clapper rails. To find an alternate channel crossing site, workers will move away from the channel to a distance where vegetation is lower in height and where visibility of the ground surface is greater, then travel parallel to the channel (e.g., avoid Grindelia).
4. **Extreme high tide**s. Activities will be scheduled to avoid work during extreme high tides when areas of tidal marsh vegetation are inundated. These are periods when California clapper rails and salt marsh harvest mice are at greatest risk (e.g., of predation). If work during an extreme high tide is necessary (e.g., for boat access to a site), activities will not occur in or near high marsh vegetation or upland/marsh transitions potentially used by California clapper rails and salt marsh harvest mice as high tide refugia.

Additional Conservation Measures for all work during western snowy plover breeding season (March I - September 14):

5. To avoid the loss of individual western snowy plovers, no activities will be performed within at least 600 feet of an active western snowy plover nest during the western snowy plover breeding season, 1 March through 14 September (or as determined through surveys). Vehicles driving on levees and pedestrians walking on boardwalks or levees should remain at least 300 feet away from western snowy plover nests and broods. In addition, personnel that must stop at a specific site for brief inspections, maintenance, or monitoring activities should remain 600 feet away from western snowy plover nests and broods. Exception: Only inspection, maintenance, research, or monitoring activities may

be performed during the western snowy plover breeding season in areas within or adjacent to western snowy plover breeding habitat with approval of the Service and CDFG under the supervision of a Service-approved biologist. If western snowy plover chicks are present and are foraging along any levee that will be accessed by vehicles, vehicle use will be under the supervision of a Service-approved biologist (to ensure that no chicks are present within the path of the vehicle).

Additional Conservation Measures for all work during California least tern breeding season (April I5- August 15):

6. No activities will he performed within 300 feet of an active California least tern nest during the California least tern breeding season, 15 April to 15 August (or as determined through surveys). Exception: Only inspection, maintenance, research, or monitoring activities may be performed during the California least tern breeding season in areas within or adjacent to California least tern breeding habitat with approval of the Service and CDFG under the supervision of a Service-approved biologist.

Additional Conservation Measures for all work during clapper rail breeding season (February 1 – August 31):

7. **Bird Behavior**. If a California clapper rail vocalizes or flushes within close range (e.g., < 10m), it is possible that a nest or young are nearby. If an alarmed bird or a nest is detected, work will be stopped, and workers will leave the immediate area carefully and quickly. An alternate route will be selected that avoids this area, and the location of the sighting will be recorded to inform future activities in the area.
8. All biologists accessing the tidal marsh will be trained in California clapper rail biology and vocalizations, and familiar with California clapper rails and their nests.
9. All crews working in the marsh during the California clapper rail breeding season will be trained and supervised by a California clapper rail biologist.
10. At sites where California clapper rail habitat and/or California clapper rail are potentially present and where any activities may need to be conducted during California clapper rail breeding season, call counts will be conducted to determine rail locations and rail territories.
11. If any activities will be conducted during the California clapper rail breeding season in California clapper rail occupied marshes, biologists will have maps or GPS-locations (where available) of the most current clapper rail occurrences at the site, and will proceed cautiously and minimize time spent in areas where clapper rail were detected.
12. All personnel walking in the marsh will be required to limit time spent within 50 meters of an identified California clapper rail calling center to half an hour or less.

Conservation Measures specific to revegetation activities:

Revegetation Activities include planting, monitoring, maintenance and seed collection. In addition to conservation measures 1-10, the following additional conservation measures will be implemented in order to ensure that revegetation activities cause as little disturbance to listed species as possible:

13. Prior to beginning monitoring, the prior year's site map will be examined and a route will be determined which will minimize the amount of foot traffic in the marsh and maximize the use of existing roads, trails, and boardwalks.

14. At least one permitted California clapper rail biologist will advise and/or review the development of plans for revegetation, revegetation management, seed collection, and revegetation monitoring.

15. Revegetation activities at sites with California clapper rails will be scheduled outside of the clapper rail breeding season (after September 1 and prior to January 31), if this is reasonably possible. If revegetation activities must be conducted within breeding season at sites where clapper rail are present:

    a. At least one clapper rail biologist will survey for clapper rail prior to revegetation activities and will be present for the duration of activities to guide revegetation crews and minimize disturbance to rails.

    b. Prior to entry to the site, the clapper rail biologist will provide a training session on clapper rail biology and characteristics of suitable nesting habitat to revegetation crews.

    c. Revegetation crews will be limited to no more than 10 people within the tidal zone or 20 people in the marsh/upland ecotone.

    d. Crews conducting revegetation activities in the tidal zone will limit time spent in the marsh to a maximum of six hours each day, once per month, and will limit time spent within 50 meters of an identified clapper rail calling center to half an hour or less. Crews conducting revegetation activities in the upland ecotone will avoid potential clapper rail nesting habitat.

16. When digging holes for planting or removing non-native vegetation, effects to existing native vegetation will be minimized.


Exhibit 2
Channel - G. stricta
Channel - S. foliosa
Levee - G. stricta
2011-2012
2006 - Grindelia stricta
Round 1
Round 2
Round 3
San Francisco Estuary Invasive Spartina Project
APPENDIX 5
0
40
80 Meters
0
180
360 Feet
Map produced: 12/22/2011
Imagery: Bing Maps
San Francisco Estuary Invasive Spartina Project
Preserving native wetlands

Exhibit 2

APPENDIX 5

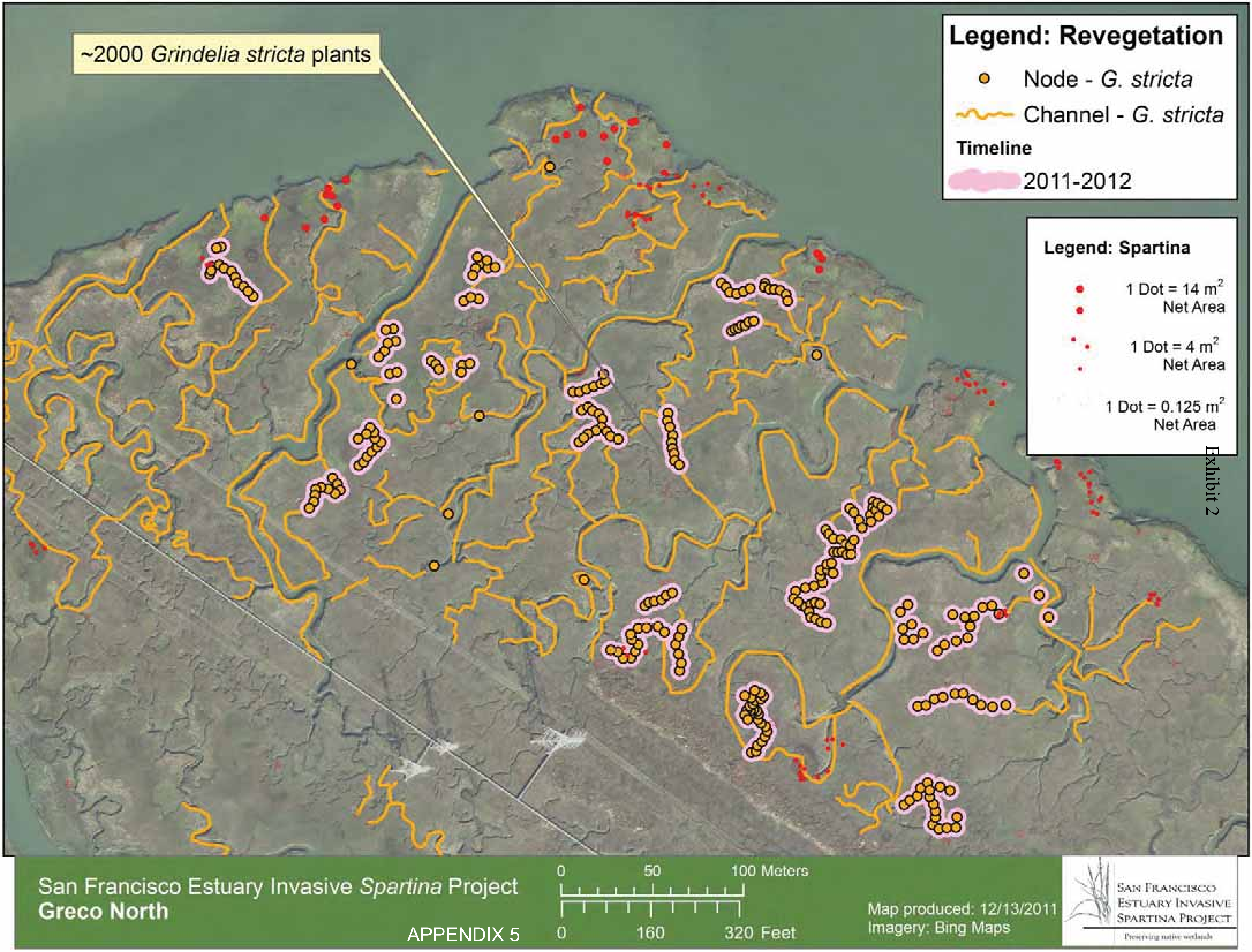

Alameda Creek
Legend: Revegetation
Channel, A - Grindelia stricta
Levee, A - Grindelia stricta
2011-2012
Estimated CLRA Locations from 2011 Call-count Surveys
1 Round 1
2 Round 2
3 Round 3
Legend: Spartina
1 Dot = 10 m²
Net Area
1 Dot = 4 m²
Net Area
1 Dot = 0.3 m²
Net Area
San Francisco Estuary Invasive Spartina Project
Alameda Flood Control Channel
0 350 700 Meters
0 610 1,220 Feet
Map produced: 12/16/2011
Imagery: Bing Maps
San Francisco Estuary Invasive Spartina Project
Preserving native wetlands

APPENDIX 5

Exhibit 2

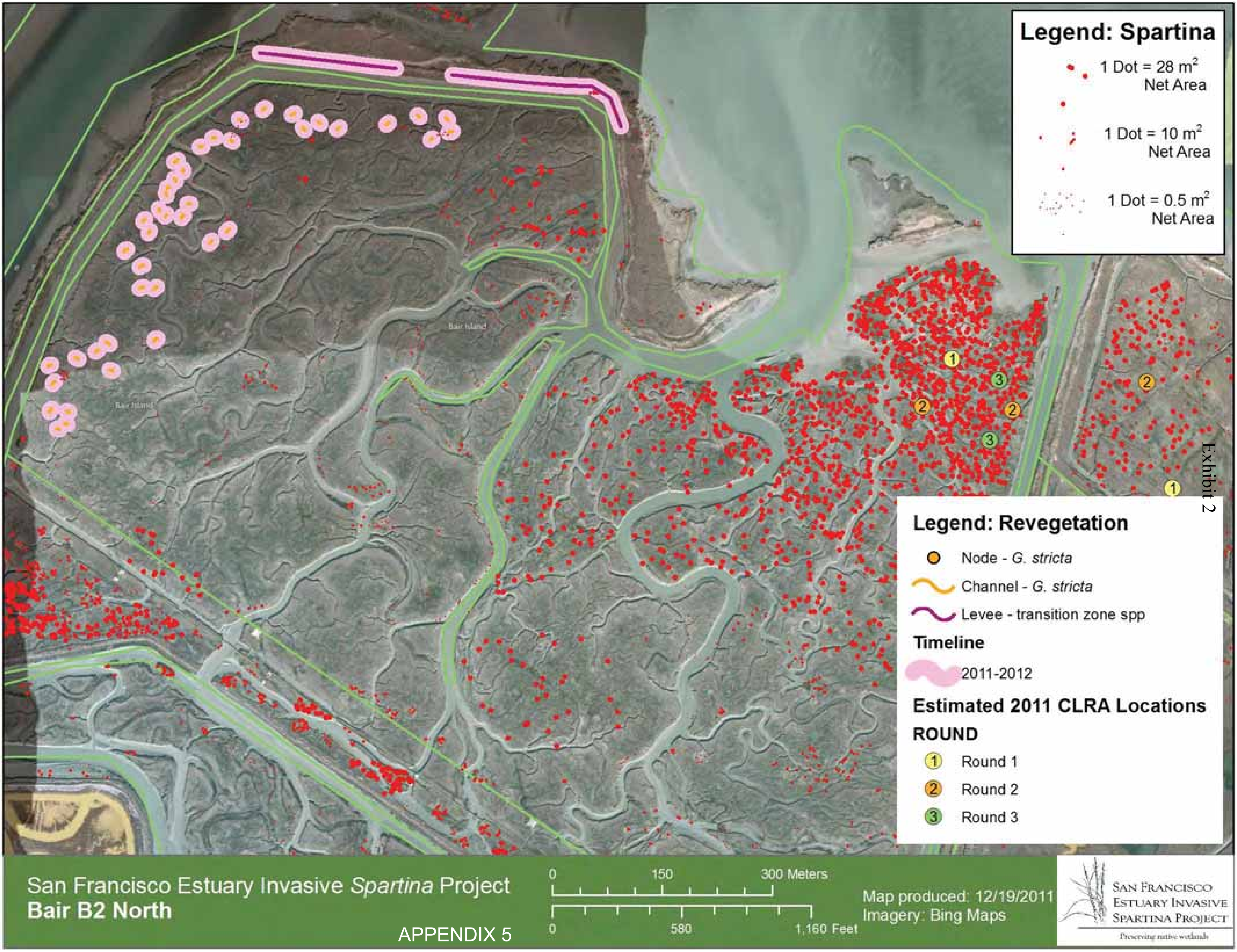
San Francisco Estuary Invasive *Spartina* Project
AFCC Mouth

APPENDIX 5


~2000 *Grindelia stricta* plants
Legend: Revegetation
Node - G. stricta
Channel - G. stricta
Timeline
2011-2012
Legend: Spartina
1 Dot = 14 m2 Net Area
1 Dot = 4 m2 Net Area
1 Dot = 0.125 m2 Net Area
San Francisco Estuary Invasive Spartina Project
Greco North
0 50 100 Meters
0 160 320 Feet
Map produced: 12/13/2011
Imagery: Bing Maps
San Francisco Estuary Invasive Spartina Project
Preserving native wetlands

APPENDIX 5

Exhibit 2



APPENDIX 5

Exhibit 2

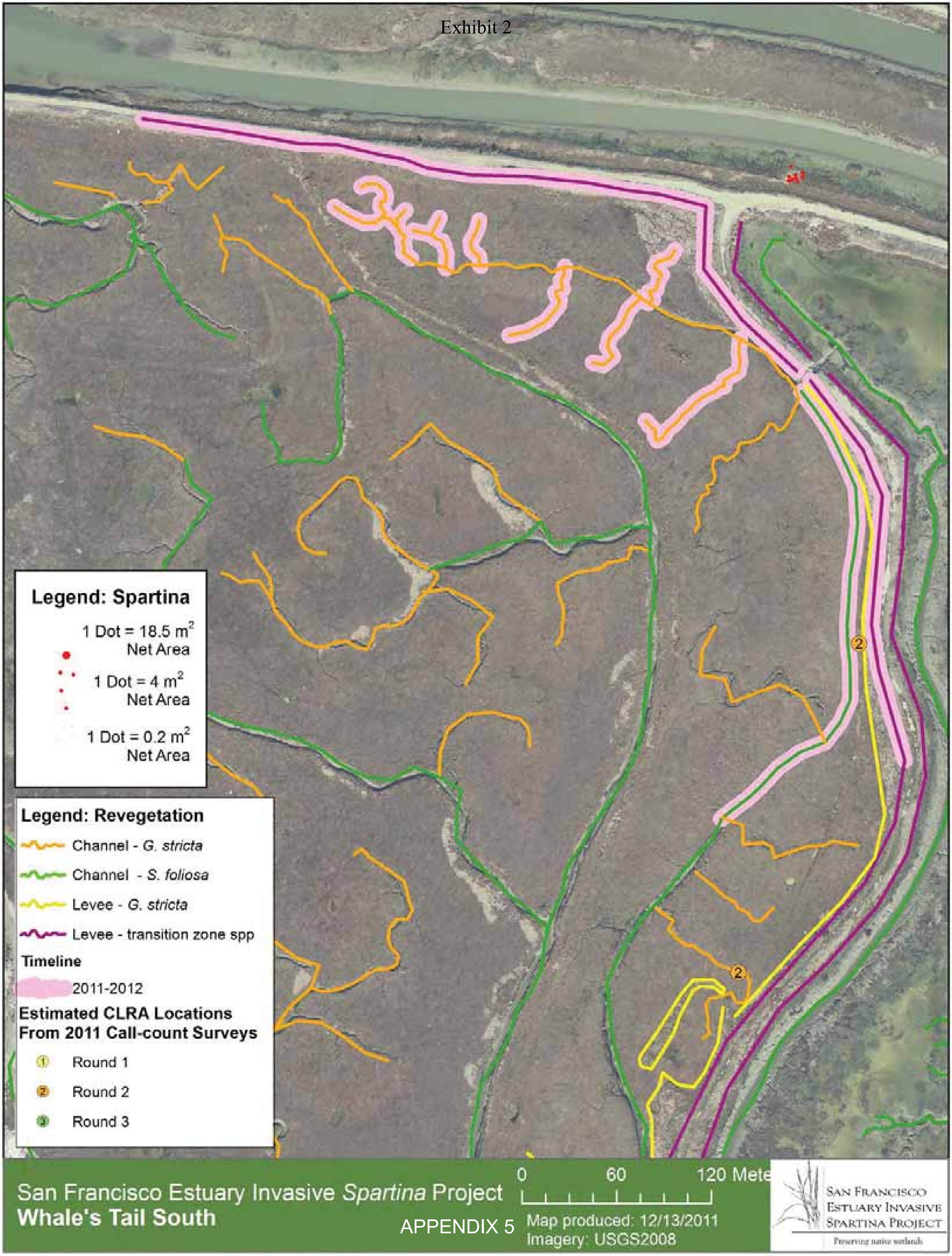


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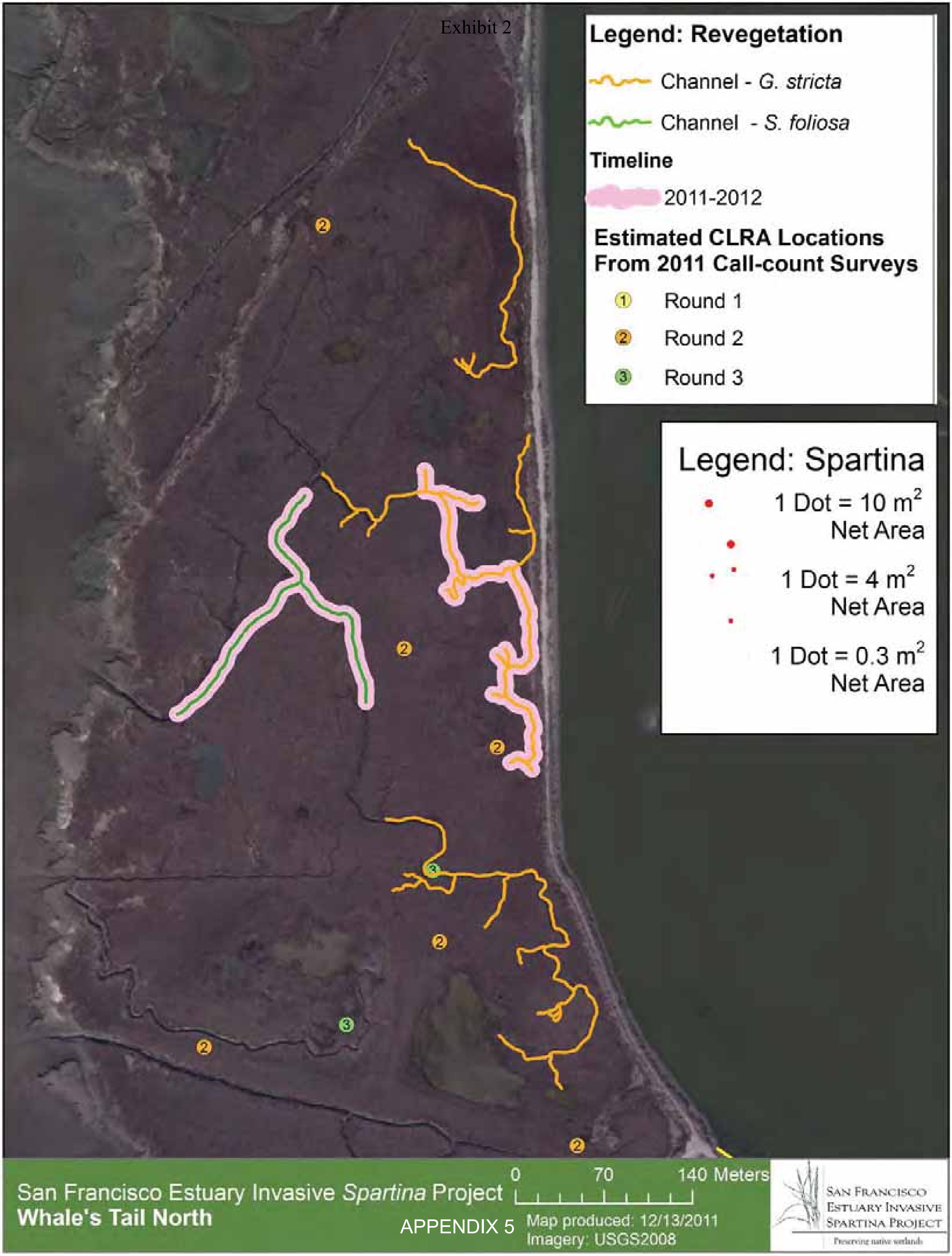
Exhibit 2



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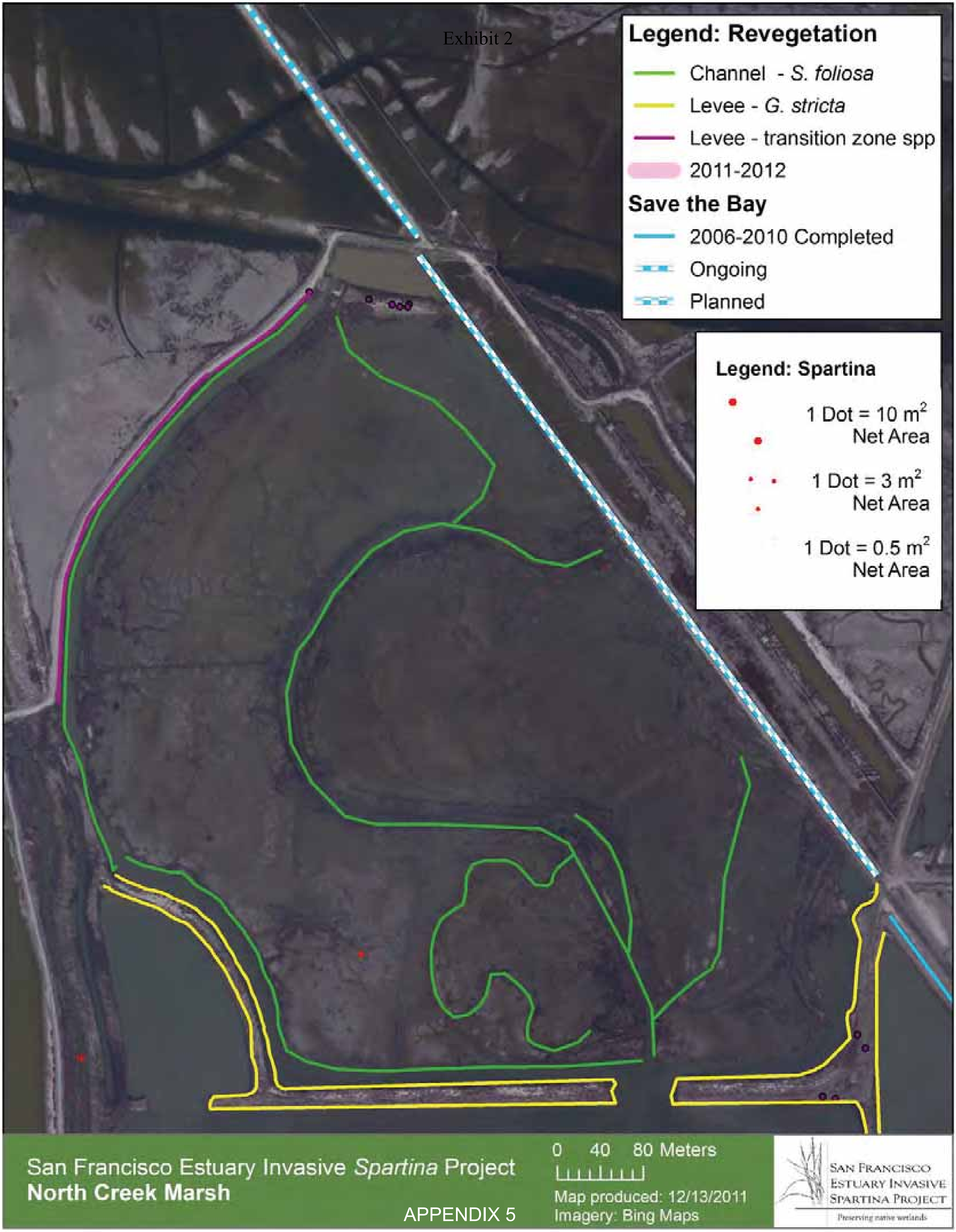

APPENDIX 5

Exhibit 2

San Francisco Estuary Invasive *Spartina* Project
Mt. Eden Creek

APPENDIX 5

Map produced: 12/13/2011
Imagery: Bing Maps

Exhibit 2

APPENDIX 5

Exhibit 2

APPENDIX 5

Exhibit 2

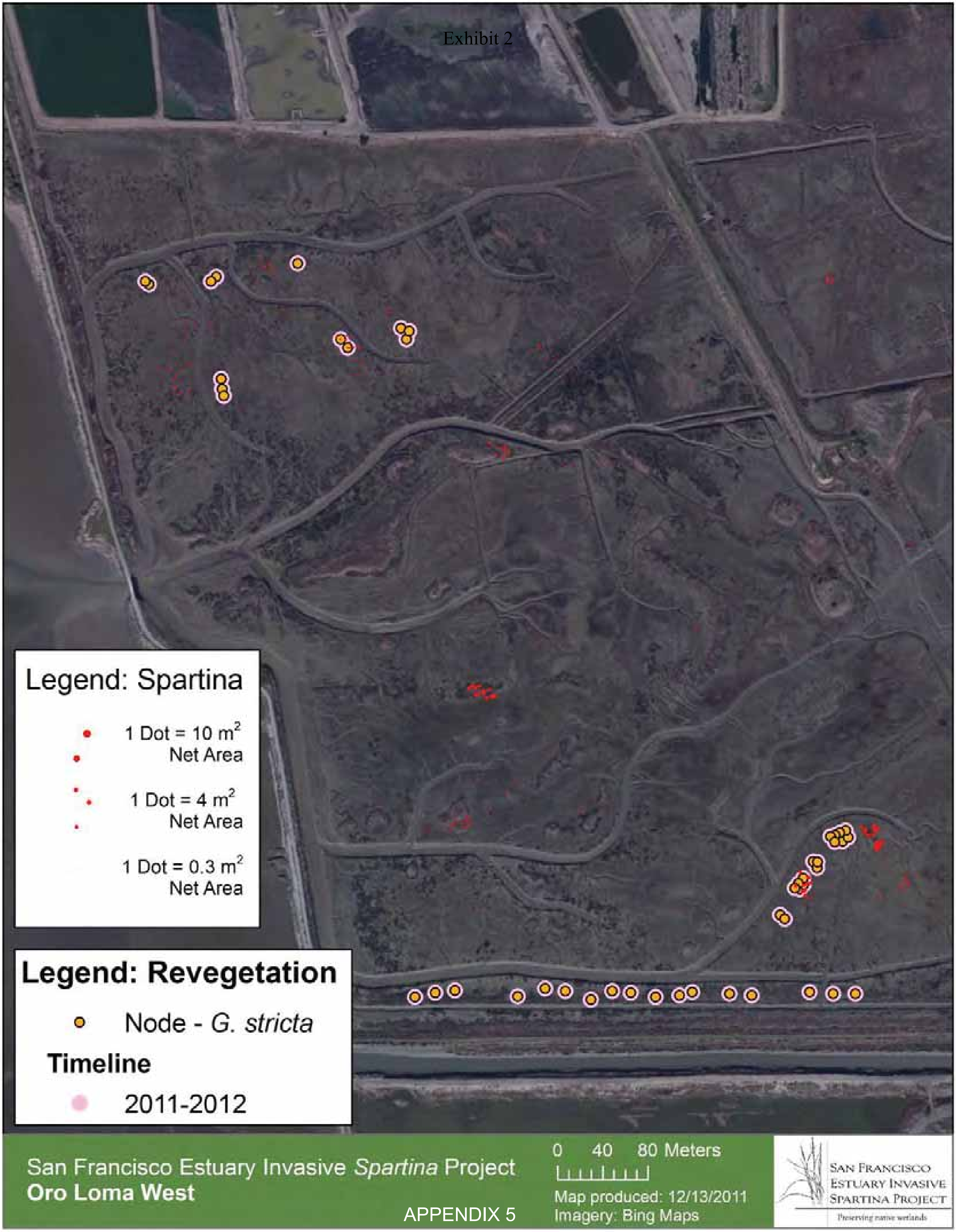
Legend: Spartina
1 Dot = 10 m2
Net Area
1 Dot = 4 m2
Net Area
1 Dot = 0.3 m2
Net Area
Legend: Revegetation
Node - G. stricta
Timeline
2011-2012
San Francisco Estuary Invasive Spartina Project
Oro Loma West
0 40 80 Meters
Map produced: 12/13/2011
Imagery: Bing Maps
San Francisco Estuary Invasive Spartina Project
Preserving native wetlands

Exhibit 2

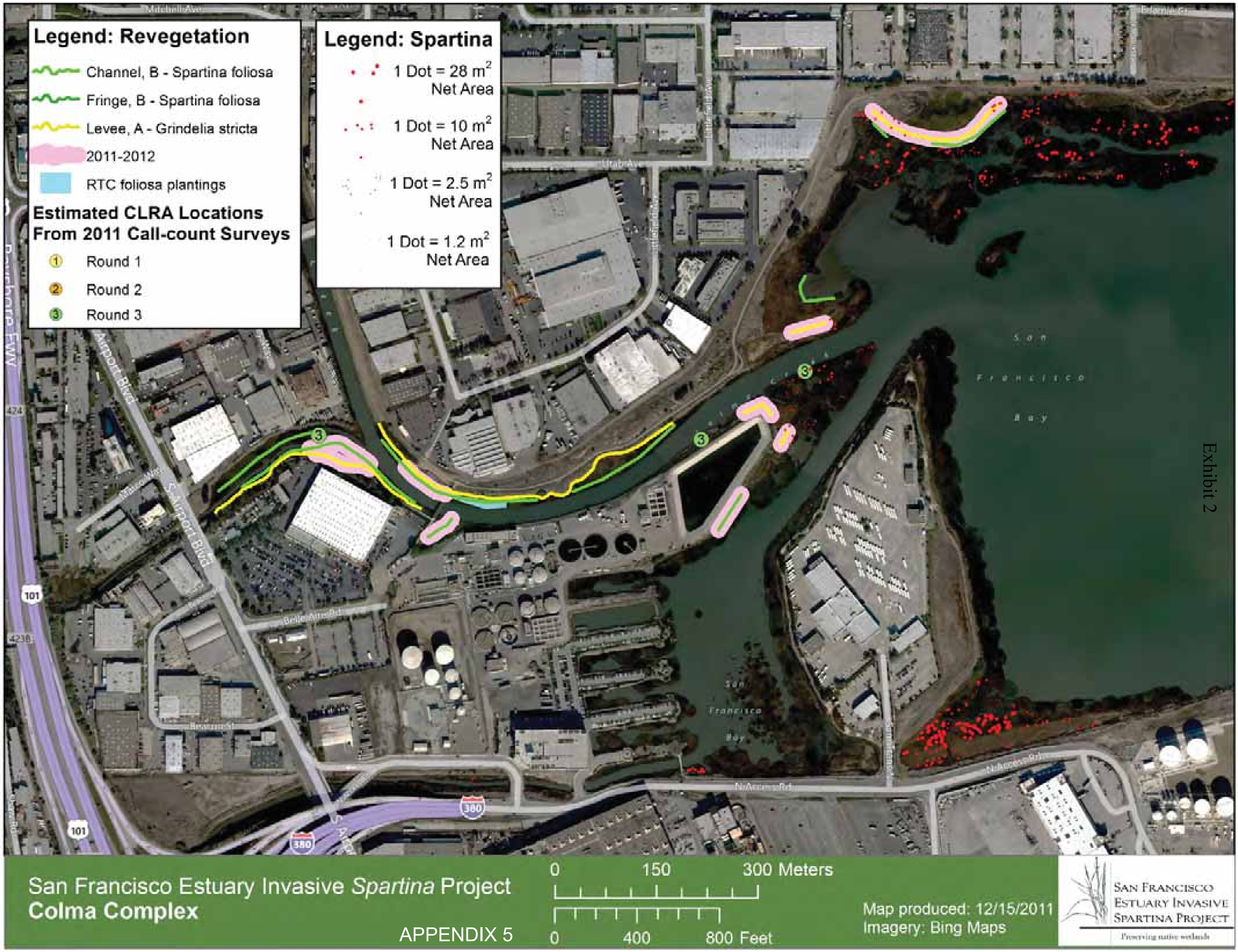
Legend: Revegetation
Channel, B - Spartina foliosa
Fringe, B - Spartina foliosa
Levee, A - Grindelia stricta
2011-2012
RTC foliosa plantings
Estimated CLRA Locations From 2011 Call-count Surveys
Round 1
Round 2
Round 3
Legend: Spartina
1 Dot = 28 m² Net Area
1 Dot = 10 m² Net Area
1 Dot = 2.5 m² Net Area
1 Dot = 1.2 m² Net Area
San Francisco Bay
San Francisco Estuary Invasive Spartina Project
Colma Complex
APPENDIX 5
0 150 300 Meters
0 400 800 Feet
Map produced: 12/15/2011
Imagery: Bing Maps
San Francisco Estuary Invasive Spartina Project
Preserving native wetlands

Exhibit 2

San Francisco Estuary Invasive *Spartina* Project

Elsie Roemer

Map produced: 12/13/2011

Imagery: Bing Maps

San Francisco Estuary Invasive Spartina Project

APPENDIX 5

Exhibit 2

Creekside Park
Substrate Preparation and Revegetation Plan 2011-2012
APPENDIX 5

0 70 140 Meters
0 200 400 Feet

San Francisco Estuary Invasive Spartina Project

Exhibit 2

APPENDIX 5

12/16/2011, 3:44 PM

Invasive Spartina Project Clapper Rail Habitat Revegetation Project Site Specific Planning Matrix

APPENDIX 6

	Winter 2011-12: 24 Total Revegetation Sites (14 ISP-led Sites; 10 Partner-led Sites)	2011-12 Sites (n=14)							
	Sub-area→Planning Consideratio	Cogswell A (20m)	Cogswell C (20o)	Alameda FC Channel Mouth, Lower & Upper (01a, b & c)	Greco Island North (02f)	Bair B2 North Quadrant (02c.a)	Whales Tail South (13e)	Whales Tail North (13d)	North Cr Marsh (Eden Landing Reserve South) (13k)
1	**CLRA Habitat Area (acres)**	35	50	233.91	498.5	283.6	149.35	149	239.4
2	**2011-2012 Reveg Notes**	portion of potential zones	portion of potential zones	portion of potential zones	portion of potential zones	portion of potential zones	portion of potential zones	portion of potential zones	portion of potential zones
3	**Plant Palette****	C, E	A	C	A, E	A, F	C, E, F	C	C, F
4	**Potential plant zones ********	1, 2, 3, 6	1, 2, 3, 6	4, 6	1	1	1, 2, 6	1, 2, 6	1, 2, 3, 5, 6
5	**2011-12 revegetation plant summary**	*Grindelia +upland transition zone; berm/l* evee prep (weed removal) for planting *Grindelia*	*Grindelia*	*S. foliosa*	*Grindelia*	*Grindelia* + upland transition zone	*S. foliosa + Grindelia + upland transition zone;* berm/levee prep (weed removal) for planting	*S. foliosa + Grindelia*	*S. foliosa + Grindelia +* upland transition zone; levee preparation (weed removal) for planting
6	**SUM: S. foliosa Total Plantings (stem #)**	**0**	**0**	**3300**	**0**	**0**	**2000**	**1000**	**4300**
7	**SUM: Grindelia Total Plantings**	**1500**	**820**	**480**	**3100**	**650**	**2040**	**1430**	**500**
8	**SUM: Triglochin mid-marsh planting**	**150**	**100**	**0**	**0**	**0**	**250**	**0**	**0**
9	**SUM: Distichlis mid-marsh planting**	**250**	**250**	**0**	**0**	**0**	**500**	**0**	**0**
10	**SUM: Levee/Upland Transition Zone Total Plantings**	**1000**	**0**	**0**	**0**	**500**	**3500**	**0**	**0**
11	**TOTAL PLANTS**	**2900**	**1170**	**3780**	**3100**	**1150**	**8290**	**2430**	**4800**
12	**Floating Island Planned**	X	X		X			X	
13	**Propagation entity ***********	TWN, other	TWN, other	TWN, STB, RTC/SFSU, other,	TWN, STB, other	TWN, STB, other	TWN, STB, other	TWN, STB, other	TWN, STB, RTC/SFSU, other
14	**Outplanting lead**	ISP	ISP	ISP, RTC/SFSU	ISP	ISP	ISP	ISP	ISP, RTC/SFSU, STB
15	**Monitoring Design Lead**	ISP	ISP	ISP, RTC/SFSU	ISP	ISP	ISP	ISP	ISP, STB
17	**Field Monitoring Lead**	ISP	ISP	ISP, RTC/SFSU	ISP	ISP	ISP	ISP	ISP, STB
18	**Field Monitoring Support**	ISP	ISP	ISP, RTC/SFSU	ISP	ISP	ISP	ISP	ISP
19	**Design Support**	ISP	ISP	ISP, RTC/SFSU	ISP	ISP	ISP	ISP	ISP, STB
20	**Owner**	EBRPD	EBRPD	AFCD	FWS Refuge	FWS Refuge	CDFG	CDFG	CDFG
20	**Manager**	EBRPD	EBRPD	AFCD	FWS Refuge	FWS Refuge	CDFG	CDFG	CDFG

Exhibit 2

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Invasive Spartina Project Clapper Rail Habitat Revegetation Project Site Specific Planning Matrix

APPENDIX 6

	Winter 2011-12: 24 Total Revegetation Sites (14 ISP-led Sites; 10 Partner-led Sites)							**Partner lead sites (n=10) >>>>**	
	Sub-area→Planning Consideratio	**Mt. Eden Creek (13j)**	**Old Alameda Creek Island (13b)**	**Oro Loma East (07a)**	**Oro Loma West (07b)**	**Colma Creek (18a)**	**Elsie Roemer (17a)**	**Creekside Park (04g)**	**Arrowhead Marsh West (17c)**
1	**CLRA Habitat Area (acres)**	124.83	93.74	197.05	130.73	6.93	17.77	20.75	43.9
2	**2011-2012 Reveg Notes**	portion of potential zones	portion of potential zones	n/a	n/a	RTC/SFSU 3 blocks	RTC/SFSU 3 blocks	FCMC work	Marsh plane work
3	**Plant Palette****	C	C	A	A	C	B	A	A, D
4	**Potential plant zones ******	1, 2	1, 2	1, 2	1, 2	3, 4	4	3, 5	1, 3
5	**2011-12 revegetation plant summary**	*S. foliosa + Grindelia*	*S. foliosa + Grindelia*	*Grindelia*	*Grindelia*	*S. foliosa* ; concern will be ecological sink for clapper rails, cat feeding stations	*S. foliosa*	*Grindelia* seedlings, substrate prep, intra-marsh transplants (*Sarcocornia* , *Frankenia*)	*Grindelia* & *Triglochin*
6	**SUM: S. foliosa Total Plantings (stem #)**	**600**	**4000**	**0**	**0**	**1800**	**1800**	**0**	**0**
7	**SUM: Grindelia Total Plantings**	**1000**	**500**	**600**	**600**	**330**	**0**	**600**	**1510**
8	**SUM: Triglochin mid-marsh planting**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**490**
9	**SUM: Distichlis mid-marsh planting**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
10	**SUM: Levee/Upland Transition Zone Total Plantings**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
11	**TOTAL PLANTS**	**1600**	**4500**	**600**	**600**	**2130**	**1800**	**600**	**2000**
12	**Floating Island Planned**								X
13	**Propagation entity *******	TWN, STB, other	TWN, STB, RTC/SFSU, other	TWN, STB, other	TWN, STB, other	TWN, STB, RTC/SFSU, other	TWN, RTC/SFSU	MCPOSD nursery	STB
14	**Outplanting lead**	ISP, STB	ISP, RTC/SFSU	ISP	ISP	ISP, RTC/SFSU	ISP, RTC/SFSU	FCM/CCNB	STB
15	**Monitoring Design Lead**	ISP, STB	ISP, RTC/SFSU	ISP	ISP	ISP, RTC/SFSU	ISP, RTC/SFSU	ISP	STB
17	**Field Monitoring Lead**	ISP, STB	ISP, RTC/SFSU	ISP	ISP	ISP, RTC/SFSU	ISP, RTC/SFSU	ISP	STB
18	**Field Monitoring Support**	ISP	ISP, RTC/SFSU	EBRPD	EBRPD	ISP, RTC/SFSU	ISP, RTC/SFSU	ISP	STB, ISP, EBRPD
19	**Design Support**	ISP, STB	ISP, RTC/SFSU	ISP	ISP	ISP, RTC/SFSU	ISP, RTC/SFSU	ISP, TWN	STB, ISP, EBRPD
20	**Owner**	CDFG	CDFG	EBRPD	EBRPD	San Mateo FCD	City Alameda	Marin Co	EBRPD
20	**Manager**	CDFG	CDFG	EBRPD	EBRPD	San Mateo FCD	EBRPD	Marin, FOCMCW	EBRPD

Exhibit 2

Invasive Spartina Project Clapper Rail Habitat Revegetation Project Site Specific Planning Matrix

APPENDIX 6

	Winter 2011-12: 24 Total Revegetation Sites (14 ISP-led Sites; 10 Partner-led Sites)									Sum (12/15/11)
	Sub-area→Planning Consideratio	MLK Marsh (17h)	East Creek Slough (17 d.3)	Damon Marsh, MLK Shoreline (17d.4)	Faber/ Laumeister (15b)	Palo Alto Baylands (08)	Revenswood Open Space Preserve/ SF2 (02j)	Bothin (23j)	Eden Creek Marsh (Eden Landing Reserve North) (13l)	
1	**CLRA Habitat Area (acres)**	34.32	11.34	27.07	197.34	217.78	23.63	106.16	229.79	
2	**2011-2012 Reveg Notes**	STB Ecotone work	STB Ecotone work	STB Ecotone work	STB Ecotone work	STB Ecotone work	STB Ecotone work	STB Ecotone work	STB Ecotone work	
3	**Plant Palette****	F	F	F	F	F	F	F	F	
4	**Potential plant zones ********	6	6	6	6	6	6	6	6	
5	**2011-12 revegetation plant summary**	Upland transition zone	Upland transition zone	Upland transition zone	Upland transition zone	Upland transition zone	Upland transition zone	Upland transition zone	Upland transition zone	
6	**SUM: S. foliosa Total Plantings (stem #)**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**18800**
7	**SUM: Grindelia Total Plantings**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**15660**
8	**SUM: Triglochin mid-marsh planting**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**990**
9	**SUM: Distichlis mid-marsh planting**	**0**	**0**	**0**	**0**	**0**	**0**	**1000**	**0**	**2000**
10	**SUM: Levee/Upland Transition Zone Total Plantings**	**1700**	**2900**	**2600**	**4000**	**9850**	**3100**	**0**	**5585**	**34735**
11	**TOTAL PLANTS**	**1700**		**2600**	**4000**	**9850**	**3100**	**1000**	**5585**	**69285**
12	**Floating Island Planned**									
13	**Propagation entity *********	STB	STB	STB	STB	STB	STB	STB	STB	
14	**Outplanting lead**	STB	STB	STB	STB	STB	STB	STB	STB	
15	**Monitoring Design Lead**	STB	STB	STB	STB	STB	STB	STB	STB	
17	**Field Monitoring Lead**	STB	STB	STB	STB	STB	STB	STB	STB	
18	**Field Monitoring Support**	STB, EBRPD	STB, EBRPD	STB, EBRPD	STB	STB	STB	STB	STB	
19	**Design Support**	STB, EBRPD	STB, EBRPD	STB, EBRPD	STB	STB	STB	STB	STB	
20	**Owner**	EBRPD	EBRPD	EBRPD	USFWS	City of Palo Alto	FWS Refuge	Marin County	CDFG	
20	**Manager**	EBRPD	EBRPD	EBRPD	USFWS	City of Palo Alto	FWS Refuge	Marin County	CDFG	

Plant Zones****:

1 = 1 - meter wide *G. Stricta* zone for channels at higher elevation for high tide refugia, nesting and cover

2 = 2 - meter wide *S. foliosa* planting zone for channels at lower elevation

3 = 1 - meter wide *G. stricta* zone around levees and upland islands for high tide refugia and nesting

4 = 2 - 10 - meter wide *S. foliosa* fringe for lower elevation/wide channels

5 = mid-marsh zone planting

6 = 1 - 3 - meter wide marsh upland (levee) transition zone planting for high tide refugia

Entities***:**

Invasive Spartina Project = ISP

Save The Bay = STB

East Bay Regional Park District = EBRPD

Friends of Corte Madera Creek = FCM

CA Wildlife Foundation = CWF

The Watershed Nursery = TWN

Literacy for Environmental Justice = LEJ

Plant Palette **:

A = *Grindelia stricta* (gumplant)

B = *Spartina foliosa*

C = *Grindelia stricta* and *Spartina foliosa*

D = Mid to high marsh species (e.g., *Distichlis spicata* , *Triglochin maritima* , *Frankenia salina* , *Jaumea carnosa*, *Limonium californicum and* mid marsh *Scirpus maritimus/Bolboschoenus maritimus* ; not including A and B.

E = Mature *Grindelia stricta* and/or *Baccharis* spp. (*B. pilularis* or *B. douglasii)* skeletons for immediate vertical structure

F = Marsh/upland (levee) transition zone and lower upland (e.g.,*Grindelia stricta (and var angustifolia), Baccharis douglasii, Artemisia californica, Leymus triticoides, Eriophyllum sp., Frankenia salina, Distichlis spicata)*

Exhibit 2

ISP Revegetation Program General Timeline

	December	January	February	March	April	May	June
Prepare planting plans	Plans completed					Prepare planting plan	
Order plants from Nursery	(done Sep-Oct 2011)						
Prepare sites (weeding)	weeding	followup					
Contracting	prepare SOWs & assist CWF as needed						
Installation		Marsh Install		>>>	Upland ecotone install		
Prepare "as built" maps				Prepare as built maps			
Habitat Assessment Monitoring					Habitat Assessment Monitoring		
Photopoints		Baseline photopoints					
Survivorship Monitoring							
Planting Method Assessment							
Maintenance	Maintenance scheduled on a site specific basis, according to weed species present, local or migratory geese, etc.						
Write Reveg Progress Report							
Final Reveg Progress Report							

	July	August	September	October	November	December	January
Prepare planting plans	Prepare Planing Plans						
Order plants from Nursery	Order plants						
Prepare sites (weeding)					weeding		followup
Contracting							
Installation							
Prepare "as built" maps							
Habitat Assessment Monitoring	Habitat Assessment Monitoring						
Photopoints		Photopoint monitoring					
Survivorship Monitoring		Survivorship monitoring					
Planting Method Assessment		Planting method assessment					
Maintenance	Maintenance scheduled on a site specific basis, according to weed species present, local or migratory geese, etc.						
Write Reveg Progress Report			Report of progress through Aug 31				
Final Reveg Progress Report				Final Rept Oct 31			

ISP Revegetation Program General Timeline

APPENDIX 7