Kent Island Vegetation Management

PROJECT DESIGN PLAN

Prepared for

Marin County Open Space District

Prepared by

Prepared by Peter Baye PhD and William Carmen PhD

October 17, 2012

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1.0. INTRODUCTION

1.1 Summary

Kent Island is a flood tidal delta within Bolinas Lagoon, located at the western tip of Stinson Beach sand spit in western Marin County, north of San Francisco (Figure 1-1) that supports a complex array of terrestrial vegetation. The only other flood tidal delta in California with similar persistent vegetation is the tiny Pickleweed Island in Morro Bay, which supports a small intertidal salt marsh with relatively low species diversity.

Most of the native terrestrial vegetation on Kent Island has been overwhelmed by weedy non-native vegetation that is adapted to relatively stable habitats, but which is poorly adapted to the long-term cycles of natural, dynamic coastal processes that form and maintain Kent Island. The predominant non-native plants are Monterey pine and cypress, iceplant, European beachgrass (marram), and acacia. All of these spread from the adjacent mainland and continue to expand over the island and displace native, low-growing grassland and herbaceous vegetation on the low dunes and sandy high salt marsh. The proposed project will remove non-native vegetation from Kent Island and facilitate the natural regeneration of native vegetation. Removal of invasive vegetation on the 29-acre project area will be accomplished primarily through salt-water irrigation and manual removal. The initial restoration phase of the proposed project is expected to begin in winter 2012 and extend through August 2013. This initial phase would be followed by five years of monitoring, continuing non-native plant removal, and replanting of native vegetation.

1.2 Kent Island vegetation and geomorphic processes

The vegetation and habitats of Kent Island have developed on a dynamic coastal landform associated with the tidal inlet of Bolinas Lagoon – a dune-capped flood tidal delta that forms a type of fetch-limited barrier island (Pilkey *et al.* 2010) in the interior of Bolinas Lagoon, a geomorphic feature unique in California (Figure 1-2). The nature of the island's vegetation is closely dependent on the long-term physical (geomorphic) processes that form the island.

Kent Island's terrestrial vegetation established on a thin cap of wind and wave deposited sand (mixed with organic debris) derived from the underlying foundation of an emergent flood tidal delta. Flood tidal deltas are a type of coastal sedimentary landform deposited by the jet of flood tidal currents (Davis and Fitzgerald 2004). The shoreward side of Kent Island is exposed to refracted low-swell and wind waves from the tidal inlet. Waves entering the tidal inlet (in both storm and calm periods) rework the tidally-deposited sand and form low beach ridges and flats, causing the mobile portions of the flood tidal delta to emerge above normal tides. The topographic relief of the island is further increased by wind transport of beach sand, either by deposition or erosion.

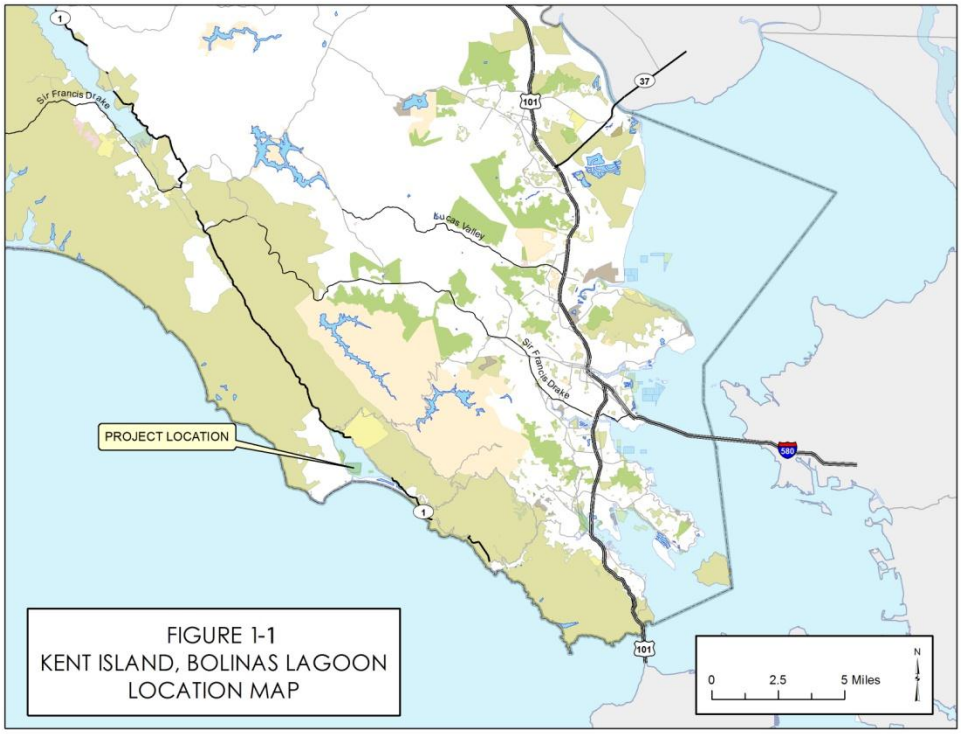

Figure 1-1. Regional map

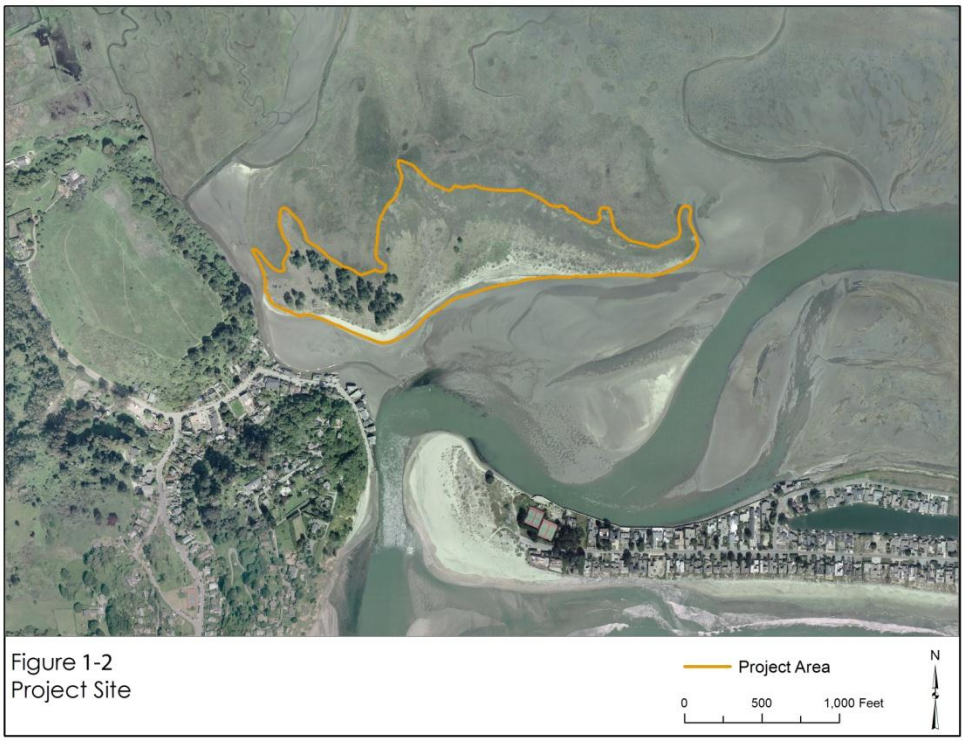

Figure 1-2. Project site map. Project area is outlined in yellow.

Drying sand along the southern shore of Kent Island is transported by onshore winds and deposited at the leading edge of shoreline salt marsh or beach vegetation. Wind-deposited sand raises island elevations above the limits of wave run-up while bare sand from the fringing beach or upper intertidal sand flats is available for transport by onshore wind. As the shoreline shifts position, relict foredunes and beach terraces become isolated low ridges in back of the active shoreline. Over decades, the island's topography has become differentiated by these processes into low-relief active foredunes and lagoon beaches, stabilized relict deflation flats and dune mounds, and salt marsh flats lacking tidal creeks.

Geomorphic processes of the island vary from continual gradual low-energy, changes in erosion and deposition, to infrequent (decadal), abrupt, intense storm erosion and deposition events to seismic subsidence expected on a time-scale of one to several centuries (Byrne and Reidy 2006). The resilience of Kent Island's ecosystem depends on a diversity of beach, salt marsh, and dune plants adapted to recover from extensive sand erosion and depositional processes and pulses of seawater flooding. Complete stabilization and maturation of the island's vegetation dominated by invasive species intolerant of seawater flooding or sand burial would reduce its ability to recover from natural coastal disturbances, and would impair its ability to maintain a high diversity of natural habitats and native species.

A contrast in land form can be seen in comparing a photo from 1907 when Kent island was comprised of a small and narrow back barrier beach with salt marsh in the background (Figure 1-3) to one in 2012 (Figure 1-4) showing an island of substantially larger size, higher elevation, and colonized by invasive trees and other non-native terrestrial vegetation.

Sea level rise has occurred throughout the last century, and it is expected to accelerate significantly in the 21st century. The vegetation of Kent Island is highly likely to undergo significant changes driven by accelerated rise in sea level in coming decades, including increased erosion, deposition, shifts in shoreline position, and submergence of terrestrial vegetation. These shifts may be either abrupt, driven by infrequent extreme events (e.g., intense El Nino storm over-wash coinciding with extreme high tides, or co-seismic subsidence associated with San Andreas fault earthquakes), or gradual changes associated with rising sea level (increased frequency and duration of seawater flooding, rising saline groundwater intrusion along the island's topographic gradient). These natural disturbances will likely cause significant disturbance, regeneration, and modification of Kent Island vegetation. Resilient native vegetation adapted to these processes is likely to facilitate recovery of the island ecosystem.

Figure 1-3. Photo of Kent Island in 1907. Note horse tracks across tidal flat and grazing horses on the island.

Figure 1-4. Photo of Kent Island in 2012.

1.2 Pioneer shoreline vegetation, invasive plants, and landforms

Shoreline vegetation influences sand transport and landform development at Kent Island. It includes many creeping native grasses (saltgrass, Vancouver wildrye, beach wildrye) that are capable of regenerating from eroded fragments, sand burial, and pulses of seawater flooding. Other important pioneer beach and salt marsh vegetation is composed of low-growing spreading forbs (broadleaf herbaceous plants) such as beach-bur, California saltbush, beach saltbush, alkali-heath, and pickleweed. This vegetation actively shapes the island over time through interaction with sand transport processes. The shoots and foliage create roughness and shelter, which in turn slows wind velocity near the sand surface and causes deposition of wind-blown sand. Similar processes occur at very high tides when waves break at the high marsh edge and trap sand in the marsh vegetation. The vegetative shoots grow through the sand deposits and trap more sand in successive layers. The shape of the vegetation canopy and patterns of vegetation creep or spread, which vary among species, affects the shape of the sand landforms deposited. As vegetation spreads to closed, continuous cover, sand is temporarily stabilized (Pethick 1984, Maun 2009).

Once sand on the island is vegetated with extensive cover, no further significant wind-transport of sand occurs beyond the shoreline edge of bare sand. Thus, the island's topography and vegetation becomes temporarily stabilized until the next shoreline erosion event reactivates it. Remnants of salt-tolerant and sand burial-tolerant vegetation persist in stabilized low dune grassland, and these resume their role as active geomorphic agents modifying sand transport when rapid erosion or deposition events occur.

In contrast, if native plants are replaced by non-native species such as iceplant, bush lupine, Monterey pine and cypress, the island's ability to recover from infrequent and extreme erosion or tectonic events is impaired (Table 1-1 lists invasive plants, the habitat types where they are found on the island, and their level of impact). In the exceptional case of invasive marram grass (European beachgrass, *Ammophila arenaria*), the unmatched ability of this species to trap wind-blown sand in a narrow concentrated zone and build steep narrow foredunes (Maun 2009, Cooper 1967) is detrimental to the formation of gently sloping shorelines that support diverse native creeping vegetation (saltgrass, wildrye species). Native beach, dune, and high salt marsh plants are inhibited by the higher rates of sand accretion (burial) caused by marram grass and the competition from marram itself. The higher dunes formed under influence of marram escape storm flooding more often than low, broad dune sheets. When the dunes become stabilized, the remnant marram dune topography facilitates the establishment of woody vegetation (pines and cypress) that is highly sensitive to seawater flooding. Marram is a keystone species because it provides threshold topographic conditions that allow mature, woody, and disturbance-intolerant vegetation to establish over vegetation that would otherwise be excluded by more frequent low-level storm flooding.

If the non-native conifer stand on Kent Island were small and remained stable, it would pose relatively little threat to the island's species diversity, ecology, and geomorphic dynamics. However, the age-structure of conifer stands on Kent Island indicate that the area, already dominated by mature conifers, is replacing itself, recruiting young seedlings, saplings, and immature trees, and allowing young saplings to spread far into the island interior. Currently, non-native conifer saplings are present throughout the central portion of the island, outlining the future canopy that may coalesce if they mature before the next extreme disturbance event. The shade and leaf litter of Monterey pine and cypress is inhibitory to native dune, salt marsh, and beach plants that naturally tolerate dynamic flood tidal delta processes. Over time, native species diversity associated with open grassland habitats would decline significantly as maturing pine woodlands expand and displace them. Many native plants would likely become extirpated on Kent Island as the conifer-dominated area increases during a temporary stable, low-disturbance phase of the island's ecological development. The proportion of the island dominated by species capable of rapid recovery from major disturbances would diminish as conifer dominance spreads.

If the conifer stand spreads to dominate a major portion of the Kent Island before the next major storm or seismic disturbance, it will impair the island's ability to recover. A conifer-dominated Kent Island would succumb to rapid dieback following storm over-wash or seismic subsidence events, and would suffer delayed recovery of beach, salt marsh, and dune because the ground layer of vegetation would be depleted of native species that would normally act as local on-site founders that rapidly recolonize. Interruption of natural re-colonization on the island may expose

Table 1.1 Invasive non-native species of Kent Island

Acacia longifolia Golden wattle. Stabilized dune grassland, woodland. MODERATELY INVASIVE but HIGHLY PERSISTENT AND HIGH IMPACT in stabilized dune grassland and woodland.

Ammophila arenaria Marram, European beachgrass. Active and stabilized dune grassland, beach. . HIGHLY INVASIVE in mobile dunes, HIGH IMPACT persisting in stabilized dunes.

Atriplex prostrata Spearscale, orache, fat-hen. Beach-salt marsh ecotone. Locally abundant to dominant, but usually successional, ephemeral dominant in drift-lines; potentially invasive, local high impact.

Bromus diandrus (& *Bromus* sp.) Ripgut brome, annual brome spp. Stabilized dune. POTENTIALLY HIGHLY INVASIVE in disturbed sand enriched by detritus (leaf litter, iceplant or conifer debris after eradication).

Carpobrotus edulis x *chilensis* Iceplant. Stabilized dune, beach-salt marsh ecotone. HIGHLY INVASIVE, HIGH IMPACT; principal weed of all terrestrial vegetation on Kent Island.

Cotula coronopifolia Brass-buttons. Salt marsh. Potentially invasive but unlikely high impact in Kent Island salt marsh.

Cytisus scoparius Scotch broom. Stabilized dune grassland. Local, rare. POTENTIALLY HIGHLY INVASIVE, HIGH IMPACT.

Dipsacus fullonum Teasel. Stabilized dune grassland.

Drosanthemum floribundum Rose iceplant. High salt marsh, stabilized dune grassland. HIGHLY INVASIVE, HIGH IMPACT in salt marsh.

Foeniculum vulgare Fennel. Stabilized dune grassland. Infrequent, but POTENTIALLY HIGHLY INVASIVE.

Genista monspessulana French broom. Stabilized dune grassland. Locally abundant. HIGHLY INVASIVE, HIGH IMPACT

Hesperocyparis macrocarpa Monterey cypress. Infrequent. HIGHLY INVASIVE, HIGH IMPACT

Lotus corniculatus Bird's-foot trefoil. Stabilized dune grassland, beach-salt marsh ecotone. Widespread, abundant, HIGHLY INVASIVE, HIGH IMPACT.

Lupinus arboreus Sims. Bush lupine (CA native; border native range limit, San Francisco Bay). POTENTIALLY HIGHLY INVASIVE.

Parapholis incurva Sicklegrass. Invasive, apparently low impact despite high abundance.

Pinus radiata Monterey Pine. HIGHLY INVASIVE, HIGH IMPACT.

Plantago coronopus Staghorn plaintain. Invasive and widespread but impact apparently moderate impact, low dominance, in Kent Island vegetatation.

it to a prolonged erosional phase and risk persistent instability during acceleration of sea level rise. This could potentially favor a shift to an alternative state of persistent unstable, sparsely vegetated sand shoals, like most flood tidal deltas in California lagoons (e.g., Drakes Estero, Bodega Harbor).

2.0 KENT ISLAND VEGETATION

Terrestrial and wetland vegetation colonized Kent Island from propagules (seeds and vegetative fragments) dispersed from the Bolinas Lagoon tidal marshes, Stinson Beach, and the terrestrial vegetation around Bolinas Lagoon. The island's vegetation has developed into a mix of native plant communities and invasive, non-native vegetation. This non-native vegetation quickly spreads, forming nearly monotypic stands (pure, single-species patches) and has replaced more diverse native plant communities, resulting in alterations to the island's geomorphic processes (sand transport patterns). Appendix A includes the results of baseline vegetation mapping of the island showing the locations of plant communities, target weed species, and rare plants.

2.1 Terrestrial coastal grassland

Native, terrestrial vegetation at Kent Island is dominated by extensive mixed stands of red fescue, *Festuca rubra* – an ecotype (local ecologically adapted population) tolerant of moderate soil salinity and sand burial rates typical of salt marsh and sand dune edges (ecotones, transition zones). Red fescue grassland on the island occurs as single-dominant stands or is associated with other salt marsh native grasses - saltgrass (*Distichlis spicata*) and Vancouver wildrye (*Elymus ×vancouveriensis* [syn. *Leymus ×vancouveriensis*]). It is also associated with beach wildrye (*E. mollis* [syn. *Leymus. mollis*]) and numerous native forbs such as evening-primrose (*Oenothera elata*).

Terrestrial grassland on Kent Island is extensively invaded by non-native, invasive plants such as:

- iceplant (*Carpobrotus chilensix* × *edulis*; see below)
- French broom (*Genista monspessulana)*
- wattle (*Acacia longifolia*)
- fennel (*Foeniculum vulgare*)
- teasel (*Dipsacus fullonum)*

Bush lupine (*Lupinus arboreus*), which native to California (south of Marin), is a weedy species that has also invaded the island's grasslands. Native species composition of Kent Island terrestrial grassland is listed in Table 2-1.

2.2 Salt marsh-beach ecotone.

Sandy high salt marsh, the transition zone between tidal wetland and terrestrial vegetation at Kent Island, is formed by stabilization of lagoon beaches or low dunes within reach of higher spring tidal flooding. Sandy high salt marsh is locally dominated by saltgrass and gumplant (Grindelia hirsutula; syn. G. stricta var. angustifolia), and a diverse assemblage of salt marsh and beach

forbs, including regionally uncommon shoreline species, such as California saltbush (Atriplex californica). This assemblage is similar to types found in limited portions of Tomales Bay and Drakes Estero shorelines. The salt marsh-beach ecotone is also widely invaded by iceplant (see below). Native species composition of Kent Island salt marsh-beach ecotone and foredune are listed in Table 2-2.

Table 2.1 – Native species composition of Kent Island terrestrial grassland

Camissoniopsis cheiranthifolia subsp. cherianthifolia Beach evening-primrose. Widespread, patchy.

Crassula connata Pygmy-weed. Occasional, patchy.

Elymus mollis Beach wildrye. Uncommon, patchy.

Elymus × *vancouveriensis* Vancouver wildrye. Common, locally dominant.

Festuca rubra Red fescue. Widespread, dominant.

Heteromeles arbutifolia Toyon. Occasional.

Oenothera elata subsp. hookeri Hooker's evening-primrose. Common, patchy.

Pseudotsuga menziesii Douglas-fir. Very infrequent.

Table 2.2 – Native species composition of Kent Island salt marsh-beach ecotone and foredune

Atriplex californica California saltbush. Infrequent.

Atriplex leucophylla Beach saltbush. Infrequent.

Cuscuta pacifica Salt marsh dodder. Common, patchy.

Distichlis spicata. Widespread, dominant.

Elymus mollis Beach wildrye. Uncommon, patchy.

Elymus × *vancouveriensis* Vancouver wildrye. Common, local dominant.

Frankenia salina Alkali-heath. Common.

Grindelia stricta subsp. *angustifolia (*intermed. subsp. *platyphylla)* Salt marsh gumplant. Common, patchy, locally abundant.

Plantago maritima Seaside plantain. Widespread, patchy.

Spergularia macrotheca Sticky sand-spurrey, patchy.

Sarcocornia pacifica Pickleweed.Widespread, patchy.

2.2.1 Iceplant invasion of terrestrial and wetland ecotone vegetation

The terrestrial red fescue grassland and ecotonal high salt marsh are extensively invaded by non-native iceplant (*Carpobrotus chilense* × *edulis*), which occurs variably in sparse, diffuse stands in dry interior areas, and in thick, robust patches where old organic wrack deposits enrich the sand. Iceplant is either frequent, subdominant or co-dominant in most of Kent Island's grassland and older high salt marsh vegetation. Iceplant modifies native vegetation by cover of both living prostrate succulent leaf canopies and persistent dead biomass (litter). Iceplant spreads into upper salt marsh zones at Kent Island even where substrate is too saline to support rooted iceplant, by extending unrooted shoots from well-drained, low-salinity uplands bordering the salt marsh. Iceplant is a significant threat to the high salt marsh zone that supports rare plants.

2.3 Monterey pine and cypress conifer stands

Monterey pines and cypress have established a substantial 5 acre grove of mature trees that have become breeding habitat for great blue herons and great egrets. Despite non-native plant invasion, stands of native red fescue and Vancouver wildrye have formed on the low-lying stabilized beach, and a species-rich forb persists in the high salt marsh. Native species composition of Kent Island conifer woodland is listed in Table 2-3.

Table 2.3 – Native species Kent Island conifer woodland

Elymus mollis Beach wildrye. Uncommon, patchy.

Elymus × *vancouveriensis* Vancouver wildrye. Common, patchy, local dominant.

Festuca rubra L. Red fescue. Widespread, dominant.

2.4 Tidal salt marsh

Salt marsh vegetation at Kent Island occurs in distinct types associated with contrasting environments such as:

- wave-exposed south-facing shorelines with active sandy lagoon beach deposition and erosion processes
- wave-sheltered, muddy salt marsh flats of the north shore bordering former wash-over and dune deflation surfaces
- steep-banked, tidally well-drained sheltered salt marsh bordering the western channel.

The southern fringing sandy salt marsh, grading into stabilized beaches, is mostly dominated by saltgrass with variable proportions of alkali-heath (*Frankenia salina*) and pickleweed (*Sarcocornia pacifica*, syn. *Salicornia virginica*). There are also numerous low-growing native salt marsh forbs including sea-lavender (*Limonium californicum*) and sand-spurrey (*Spergularia macrotheca*).

The wave-sheltered intertidal salt marsh that fringes Kent Island's west and north shores is dominated by native salt marsh plants with relatively high diversity. There is a low occurrence of pickleweed and saltgrass, which is a condition typical of sandy to peaty salt marshes of west Marin. The high salt marsh zone of the north shore of Kent Island has low-growing, turf vegetation with the highest salt marsh plant diversity. This habitat includes a fine-grained, diffuse mosaic of sea arrow-grass (*Triglochin concinna*), sparse pickleweed, saltgrass, sea-lavender, sand-spurrey, and sea-plantain (*Plantago maritima*). Staghorn plaintain (*Plantago coronopus*) and bird's-foot trefoil (*Lotus corniculatus*) occur in the brackish sand of the uppermost salt marsh. Highly invasive trefoil is abundant in low mounds along the terrestrial edges of salt marsh, where it dominates the habitat of rare salt marsh owl's-clover (*Castilleja ambigua* subsp. *ambigua*).

Table 2.4 – Native species composition of Kent Island tidal salt marsh

Atriplex californica California saltbush. Occasional.

Castilleja ambigua Hook. & Arn. subsp. *ambigua* Salt marsh owl's-clover. Widespread, patchy.

Chloropyron maritimum subsp. *palustre* Northern salt marsh bird's-beak. Widespread, patchy.

Cuscuta pacifica Salt marsh dodder. Widespread, patchy.

Distichlis spicata Saltgrass. Widespread; co-dominant.

Frankenia salina Alkali-heath. Widespread; co-dominant.

*Grindelia stricta subsp. angustifolia (*intermed. subsp. *platyphylla)* Salt marsh gumplant. Widespread; abundant at high marsh edge.

Jaumea carnosa Fleshy jaumea. Widespread, co-dominant.

*Juncus balticus (*syn. *J. arcticus* subsp. *balticus)* Baltic rush/salt rush (intermediate). Local, brackish marsh depression with intermittent winter extreme high tide flooding.

Juncus bufonius Toad rush. Widespread, patchy but abundant and tiny. Native status of undetermined subspecies presumed.

Limonium californicum California sea-lavender. Widespread.

Plantago maritima Seaside plantain. Widespread.

Potentilla anserina subsp. *pacifica* Silverweed. Local, brackish marsh depression with intermittent winter extreme high tide flooding.

Spergularia macrotheca Sticky sand-spurrey. Widespread.

*Sarcocornia pacifica (*syn. *Salicornia pacifica)* Pickleweed. Widespread, co-dominant.

Triglochin concinna Creeping sea-arrow grass. Widespread, co-dominant.

The narrow western salt marsh (bordering the tidal channel and Monterey pine stand) is dominated by pickleweed and alkali-heath, and supports a large infestation of non-native rose iceplant (Drosanthemum floribundum). This is the only known salt marsh population north of Santa Barbara. Native species composition of Kent Island tidal salt marsh is listed in Table 2-4.

3.0 RARE PLANT CONSERVATION

Kent Island is occupied by populations of two rare annual salt marsh plants - the north coast salt marsh bird's-beak (*Chloropyron maritimum* subsp. *palustre*; syn. *Cordylanthus maritimus* subsp. *palustris*) and a salt marsh ecotype (ecologically adapted population) of owl's-clover (*Castilleja ambigua* subsp. *ambigua*). These salt marsh annuals inhabit the sparse, low-growing turfy high salt marsh in the lee of Kent Island, along the edges of its north shore. The abundance of these annuals varies considerably among years, presumably influenced by seasonal rainfall patterns, insect predation of fruits and seeds, and changes in salt marsh vegetation structure. The owl's-clover is less salt-tolerant than bird's-beak and is typically dwarfed; it may be absent or scarce in relatively dry, saline years. Table 3-1 lists the status of rare plants of Bolinas Lagoon beach, dune and salt marsh, and Appendix A includes maps showing the distribution and location of rare plants from surveys conducted in the spring of 2012.

Bolinas Lagoon was the original locality where a rare coastal plant, the coast marsh milkvetch (*Astragalus pycnostachyus* var. *pycnostachyus*), was discovered in the 19th century. It has been extirpated from the lagoon, but occurs in Drakes Estero along the high tide line of sandy salt marshes. Kent Island is the only location within Bolinas Lagoon that still provides a substantial amount of appropriate habitat for this species. Another rare beach plant that occurs in one large, erosion-prone colony at Stinson Beach, is the north coast pink sand verbena (*Abronia umbellata subsp. breviflora*). June 2012 surveys found two individuals of this species on Kent Island, and confirmed that suitable habitat is present on parts of the shoreline. This project proposes to restore coast marsh milkvetch to its type locality by introducing seeds and transplants from nearby Drakes-Limantour populations into suitable habitat at Kent Island. Pink sand verbena is also proposed for translocation to Kent Island from the exposed Stinson Beach population.

Table 3-1 Status of rare plants of Bolinas Lagoon beach, dune & salt marsh

Species	***Status*** Fed/State/CNPS	**Occurrence**
North Coast pink sand-verbena *Abronia umbellata* subsp. *breviflora*	SC / – / 1B	Extant east Stinson Beach foredune population, many thousands 2010-2011. Two plants detected on Kent Island in 2012 and suitable habitat exists along beach and beach-salt marsh ecotone edge.
coast marsh milkvetch *Astragalus pycnostachyus* A. Gray var. *pycnostachyus*	– / – / 1B	Historic type locality at Bolinas Lagoon, unspecified location; most recently collected by J.T. Howell 1945 at Stinson Beach (likely backbarrier lagoon shore), W.S. Cooper 1925. Receptive suitable habitat throughout beach-salt marsh ecotone.
salt marsh owl's-clover *Castilleja ambigua* Hook. & Arn. subsp. *ambigua*	FSC/-/4.2	Widespread in backbarrier salt marsh ecotone, north side of Kent Island, mostly unbranched dwarfed plants, above bird's-beak zone, associated with sparse depauperate cover of pickleweed, seaside plaintain, saltgrass, and sicklegrass
North Coast salt marsh bird's-beak *Chloropyron maritimum* (Benth.) A. Heller subsp. *palustre* (Behr) Tank & J.M. Egger	SC / – / 1B	Widespread in backbarrier salt marsh, high marsh zone with sparse, low turf-like salt marsh vegetation, often in association with creeping sea-arrow grass, seaside plantain, California sea-lavender, and depauperate pickleweed, saltgrass, alkali-heath.
Marin knotweed *Polygonum marinense* T.R. Mert. & P.H. Raven Marin knotweed	SC / – / 3	Not detected at Kent Island or surrounding brackish to salt marsh edges of Bolinas Lagoon. Native status and taxonomic affinity uncertain; spreading like invasive species in San Francisco Estuary.

FSC: Federal Species of Concern
List 1B - CNPS 1B List, Endangered, Threatened, or Rare in California
List 2- CNPS List 2 plants are rare, threatened, or endangered in California, but more common elsewhere
List 3- CNPS List 3 plants are rare and needing more information/evaluation
List 4 – CNPS List 4.2 plants have limited distribution and are fairly threatened in California

4.0 ECOLOGICAL GOALS FOR KENT ISLAND VEGETATION MANAGEMENT AND RESTORATION

4.1 Primary Goals

1. Rehabilitate ecosystem resilience from extreme disturbances and accelerated sea level
2. Increase biological diversity of native island terrestrial and wetland plant communities (including habitat for rare plants)
3. De-anchor the island to allow its natural function as a dynamic flood-shoal island and thereby improve hydrologic function and sediment transport in Bolinas Lagoon

4.2 Near-term objectives

1. Re-establishment and maintenance of native coastal grassland dominated by red fescue, Vancouver wildrye, saltgrass, and associated native coastal dune and beach forbs
2. Re-establishment of beach and dune topographic gradients supporting broad ecotones among plant communities
3. Suppression of non-native, invasive species (e.g., conifers, marram, iceplant, French broom, acacia, bush lupine, and fennel)
4. Re-establishment of coastal marsh milk-vetch and pink abronia
5. Protection and promotion of native plants, especially northern salt marsh bird's-beak and salt marsh owl's-clover.

4.3 Long-term objectives

1. Improve the island's ability to restore native vegetation following extreme storm events within one to five years
2. Primary ecological succession following seismic events and recovery of most native vegetation within 15 years

5.0 GENERAL WEED MANAGEMENT METHODS

Kent Island weed management and re-vegetation will incorporate measures to address the constraints of the area, including:

- Limitations on freshwater supplies
- Proximity of sensitive noise and visual receptors (i.e., Stinson Beach and Bolinas)
- Stockpile and staging areas
- Proximity of environmentally sensitive tidal lagoon
- Availability of suitable hauling

The management methods focus on vegetation treatments that are likely to work under these constraints and are different from those on mainland management sites.

5.1 Seawater irrigation and flooding (sand salinization)

All of the invasive, non-native plants at Kent Island have relatively low tolerance to elevated substrate salinity during periods of active growth and transpiration (spring and summer), compared with native salt marsh and beach ecotone species. All the native salt marsh ecotone species have high substrate salt tolerance and most of the native grassland dominant species have moderate salt tolerance. The project exploits this differential salt tolerance of non-native by

manipulating substrate salinity. Seawater irrigation is a substrate conditioning alternative to herbicide use in naturally salt-tolerant vegetation types invaded by less tolerant weeds.

Moist sand is rapidly infiltrated by surface flooding by seawater (salinity near 34 ppt, 3.4% total dissolved salts). The substrate of Kent Island is mostly highly permeable medium-grained sand with little organic matter, which has limited capacity to retain salts after leaching by heavy winter rains. Using seawater irrigation to increase substrate salinity would establish a transient selective environmental condition that would adversely affect non-native vegetation with minimal impacts on native plants.

Growth inhibition and mortality of salt-intolerant weeds can be achieved by conditioning the sandy substrate with seawater irrigation during different times of the year, in relation to plant life-history and stage of development specific to each weed species. Two sensitive seasonal windows for saline irrigation impacts are: (a) fall seedling germination season and (b) the spring and summer growing season.

Rapid, deep flooding or irrigation with seawater within a treated patch of the island would need to penetrate the entire rooting zone during the growing season to cause a seasonal pulse of extreme soil salinity sufficient to kill target weeds. Root zone substrate salinity of the treated patch would decline after the following winter rains. This artificial pulse of salinity would emulate many aspects of maximum summer solstice (perigean) high tides, and rare natural storm over-wash events that occur either relatively late or early in the growing season instead of the winter dormant rainfall season, when plants are less salt-sensitive.

Elevated soil salinity in the entire root zone during summer causes injury, stress, and mortality of salt-sensitive weeds. Elevated summer soil salinity does inhibit growth and cause physiological stress and early senescence in native salt-tolerant plants, but they are relatively less likely to suffer mortality or severe reduction in regrowth in the following growing season, after winter rains flush applied salts.

Marram grass and iceplant can tolerate seawater flooding in winter during dormancy and can survive brief pulses of high salinity by regenerating from buds after shoot dieback. However, prolonged high substrate salinity is lethal to marram (Maun 2009) and iceplant. Their ability to resist salt injury is reduced by mechanical injury and clonal fragmentation – severing shoot and root connections that enable them to transfer water among shoots, and exposing injured leaf surfaces to contact with salt. Acacia, fennel, bush lupine, and conifers have no physiologically significant salt tolerance, and flushing of their root zones with seawater during the growing season would cause severe or complete morality of seedlings and adult plants. These species may, however, regenerate in subsequent years from persistent, resistant dormant seeds. Two successive growing seasons of sufficient seawater irrigation would result in mass dieback or extirpation of these weeds within treated areas. Low densities of survivors and low-vigor re-sprouts would then be amendable to manual removal with little effort.

Saline irrigation in shallow surface sand layers (10 cm or less) during the early fall germination period (particularly early in the germination season when seedling roots are still shallow) is also a technique of causing mass mortality of emerging salt-intolerant weed seedlings. Seawater injury

to seedlings may occur from both direct leaf desiccation on contact and from root contact injury and uptake of salt.

Saline irrigation can also be applied to inhibit regeneration of weeds that were previously treated manually or species that regenerate from seed banks after disturbance. Survivors and seedlings with small root systems are relatively susceptible to acute salt injury and persistent salt-intolerant survivors would be unable to sustain growth in elevated substrate salinity.

Seawater irrigation leaves well-drained sand with no significant long-term residual elevated salinity after winter rainfall. Salt-irrigated dune sand would be receptive to winter transplanting or seeding with relatively salt-tolerant native species either the first or second winter after growing season treatment, depending on rainfall. Moderately to strongly salt-tolerant native species, such as saltgrass, alkali-heath, Vancouver wildrye, and California saltbush, would regenerate in the spring following seawater irrigation treatment.

The water intake/pump/pipe locations and irrigation methods are described in Section 9.3.

5.2 Clonal fragmentation and scarification

This is a supplementary management to reduce salt tolerance by fragmenting creeping plants with widespread root systems. Iceplant bordering salt marshes grows into substrate too salty to allow for direct growth of rooted plants by extending unrooted shoots over the salt marsh surface and transferring water through long branches. Severing the branches at the base of contact with non-saline terrestrial substrate will isolate portions of the clone growing over salt marsh and inhibit growth. Severing internal portions of the clonal shoot and root system and trampling injury of foliage will increase exposure and injury of the clone from seawater irrigation. Similarly, marram grass clone's ability to maintain reserves of below-ground rhizome buds to regenerate after seawater irrigation injury is impaired by disconnecting and isolating segments of the clone.

5.3 Mattock and manual pulling

Manual removal of herbaceous and succulent perennial weeds is labor-intensive and slow, but effective for confined vegetation patches where selective fine-scale removal is appropriate (e.g., where weeds are interspersed with a significant proportion of native vegetation). Manual methods are adapted to local plant morphology and substrate conditions. Hand pulling in sandy, loose substrates is often feasible for small shrubs such as French broom. Iceplant with young, long shoots that have high tensile strength and young, shallow roots may be pulled up from sand in lengths exceeding 2 meters; however, old iceplant tends to fragment and resist pulling in large segments. Mattocks may be more efficient for manual removal of old, diffuse stands, depending on individual worker preference and techniques. Mattocks are most efficient for removal of deep tap rooted forbs (such as fennel), saplings, and small shrubs like French broom or bush lupine.

Manual removal of perennial plants will require temporary stockpiling and final disposal. Tarps will be placed below and above stockpiles and debris treated to reduce viability by desiccation, self-shading and composting, or saline irrigation. Debris stockpiles will be placed in locations where they will not create esthetic nuisances. Final disposal of debris will occur on-site (to avoid impacts of hauling and staging barges) in pits dug deep enough to prevent regeneration (0.5 meter

cover, monitored for re-sprouts). These pits will be nearer the center of the island at higher elevations.

5.4 Girdling

Girdling is a manual method of weakening, inhibiting growth, or killing single-trunk woody plants that normally lack the ability to re-sprout from buds. Girdling involves cutting a complete or near-complete circle of bark and cambium (underbark tissue generating new wood) around the trunk, exposing the core wood of the shrub or tree over a width that cannot be bridged by scar tissue before the root system dies. A near-complete girdle will severely inhibit growth and injure the tree or shrub and a complete girdle will generally kill a tree or shrub within one year. Girdling allows the tree or shrub to gradually die and decay while standing and develop slowly into snag habitat (cavity structure, invertebrate habitat). It also avoids the rapid disturbance, intensive labor, costs and impacts (including esthetic impacts) of direct tree felling, slash stockpiling and disposal. Where standing snags do not pose human safety hazards, and do provide habitat benefits, girdling is an alternative to felling or cut-stump herbicide use. Girdling also can be done to create snags that are easier to dispose of than freshly killed trees on an island. This will be the primary treatment method for larger trees that are outside of the primary grove.

5.5 Pruning and felling

Small sapling trees and intermediate sized-shrubs with narrow single trunks (under 10 centimeters diameter) can be cut below-surface with a sharp, curved pruning saw. Dense evergreen conifer slash locally generated on the island may be recycled for use in smothering methods of weed control (see below).

5.6 Smothering methods

Smothering methods involve placing layer over a discrete weed patch to create a dark, warm and humid microclimate to kill vegetation. Organic mulches, geotextile or plastic tarps, black plastic, wood, slash, or debris may be placed over vegetation to provide opaque cover that prevents photosynthesis, increases respiration, depletes stored reserves (i.e., blanches and starves the plant), facilitate pathogens, and increase shelter for herbivores. The efficacy of various smothering techniques depends on species and setting. Perennial species with abundant below-ground storage organs (roots, tubers, rhizomes) are most difficult to eradicate by smothering in one growing season, particularly shade-tolerant species. The weeds on Kent Island that are a candidate for this treatment are shade-intolerant and have at most moderate root/rhizome reserves. High coastal winds make tarps, geotextiles, and black plastic challenging to anchor and fasten into place, but felled trees and limbs may make expedient weights. Slash generated from felling, placed in one meter piles directly over target weed stands, or on black plastic, would be practical to re-use for smothering discrete weed patches. Distributing slash and bucked tree trunks and limbs for one to two years in smothering methods would facilitate gradual on-site debris management and disposal, reducing its volume before final disposal in on-site pits.

5.7 Herbicide application

The project uses a variety of treatment methods (e.g., saltwater irrigation, girdling, smothering, and other methods described above) to treat weeds on the island. These methods minimize the need for herbicides. However, weed management requires an adaptive approach that allows for additional tools to be employed if initial removal methods are not effective. To this end, the project could potentially include spot wick or brush application of herbicides as a contingency. Any herbicide treatment on the island will be carried out consistent with the Marin County Integrated Pest Management (IPM) Ordinance.

6.0 RE-VEGETATION AND REINTRODUCTION METHODS

6.1 Reliance on natural re-colonization and succession

Most areas of Kent Island that support at least low to moderate density of native vegetation in large weed treatment areas will rely primarily on natural re-colonization and succession. Most vegetation gaps will probably not require active replanting to establish native vegetation with species diversity comparable to relatively intact (low-weed frequency cover) vegetation stands. This is expected because of the relative abundance of plant propagules of native dominant species in most of the island vegetation matrix, and the suitability of the substrate for their re-colonization in vegetation gaps created by weed removal. Selective re-vegetation of treated areas would be indicated by monitoring results that provide evidence of relatively slow re-colonization of native species after two years of spontaneous re-colonization and recovery. Monitoring a reference set of plots with intact vegetation would establish a concurrent, variable baseline for establishing empirical quantitative criteria for native species diversity within a three- to five-year re-establishment period.

6.2 Transplanting dominant species

Active re-vegetation with native species would be justified in specific treatment patches that meet any of the following qualitative criteria: (1) patches are initially barren or nearly so; (2) larger weed removal patches are slow to re-colonize with native species after two growing seasons following completion of primary weed removal actions; (3) patches act as centers of concentrated weed seedling recruitment and re-occupation in the first two years following completion of primary weed removal treatments. The reliance on passive recruitment is consistent with the basic goal of ensuring that the rehabilitated native vegetation of the island be managed to enable it to regenerate following disturbances.

Active re-vegetation would rely primarily on winter transplanting of dormant bare-root vegetative divisions of native species that are derived from abundant on-site borrow populations. Tussock-forming and creeping grasses are particularly well-suited to this method. Primary reliance on local onsite division and transplanting of abundant local stock also eliminates the possibility of off-site weed, insect, or pathogen introduction from nurseries, use of poorly acclimated stock, genetic artifacts of propagation and cultivation, and energy and water costs of propagation

materials and facilities. In addition, use of on-site stock plants eliminates the cost, labor, and logistics of unnecessary nursery production.

Transplanting and aftercare techniques would involve careful timing of transplanting with prolonged periods of wet, cool winter weather to ensure minimal transplanting stress or shock and high survivorship of transplants. Irrigation would not be used and very minimal post-transplanting manual watering would be employed only in cases of winter drought. Management of post-transplant moisture stress would be achieved by small wood debris shelters, pruning, and depth of burial in sand. Minimal supplemental nutrient addition (fertilizer diluted in suspension with mud in which roots and rhizomes are dipped prior to transplanting) would be employed in transplant methods; no broadcast addition of nutrients would be appropriate for the naturally low-nutrient terrestrial grassland vegetation. Small amounts of compost generated from debris stockpiles generated by weed removal may be recycled in transplanting, but soil amendments are otherwise not recommended.

Direct seeding with native perennial dominant species is not proposed for re-vegetation, except on a small experimental scale, if at all. Seedling recruitment of dominant native perennials is likely to be very low in almost all years except the most favorable: very wet winters and late wet springs following summers with high production of viable seed. Native wildrye species have naturally low rates of viable of seed set, and rely primarily on clonal spread to increase population size. Vegetative divisions are expected to have relatively high survivorship and growth rates except in winters with long rainless, windy or dry warm intervals, followed by springs with low rainfall or none.

6.3 Off-site propagation of rare, native species and direct seeding

Some uncommon-to-rare species may require off-site propagation, on-site or off-site collection, and direct seeding to establish additional populations at Kent Island. On-site seed collection and translocation would be the only feasible and appropriate method for increasing the distribution and number of colonies of the rare salt marsh annual hemiparasitic bird's-beak and owl's-clover. Mature capsules with viable seed (inspected for insect predation of seed; less than 5% of the total capsule production per plant) would be collected in years of peak population size and seed production, and directly seeded into suitable, receptive microhabitats on the north side of the island indicated by associated species and vegetation structure – specifically, low (<15 cm maximum height), sparse high salt marsh cover (>30% soil/algal mat exposed) with high frequency of sea-lavender, creeping sea-arrowgrass, sea-plantain, and dodder (*Cuscuta pacifica*) and low abundance but high frequency of saltgrass, pickleweed, and alkali-heath. This plant assemblage is likely to provide adequate suitable host plants for these hemiparasitic species and suitable gaps for seedling emergence and growth. Seeding microsites would also target natural low mounds (high salt marsh ecotone) in the north shore salt marsh edge formerly occupied by bird's-foot trefoil patches, removed by weeding. Winter high tides would be expected to redistribute many or most of the buoyant seeds (reticulate seed coat) sown. The opportunistic, population-dependent nature of these annual forb seed translocation efforts indicates the need to schedule them over multiple years. More than one year may be required to detect episodic recruitment of seeded populations; emergence of seedlings may not necessarily occur in the

spring following seeding, but may occur one or more years later. Rainfall and salinity patterns may strongly influence emergence and survival of these annual salt marsh forbs (Allison 1995).

North coast pink sand verbena is proposed for "seed" collection from the proximal end of the Stinson Beach sand spit (Golden Gate National Recreation Area). Seed collection will take place from artificially graded foredunes where a large population has expanded, producing many thousands of fruits with viable seed annually. Dried, detached fruits that fail to disperse, concentrated around mother plants (minimum 10 seed donor plants, normalized numbers of seed from each, less than estimated 5% fruit production of each donor plant) would be collected in September-October, before fall rains. Seed would be directly sown slightly below the sand surface in the high tide line of stable to prograding "pocket" beach sites on the south shore of Kent Island, primarily the southern "point" and central south-east shore. Eelgrass or fucoid algal wrack would be loosely incorporated in sand beneath the shallow-sown seeds to provide locally enhanced nutrient availability for seedlings that emerge in place. Most fruits sown would be expected to be redistributed by waves and high tides in winter. Population reintroduction methods for north coast pink sand-verbena would be adapted from projects implemented in swell-exposed ocean beach settings in Oregon (Kaye *et al.* 2006, Thorpe *et al.* 2010). Episodic recruitment of pink sand-verbena may lag more than one year following sowing, particularly if storms re-disperse most fruits. Abundant first-year fall germination and emergence has been observed at Stinson Beach some years, however. The number of fruits available for translocation would depend on permits from Golden Gate National Recreational Area, but seeding rates approaching 500 fruits/year over a five-year period are recommended. Seed translocation should cease when a population of over 20 reproductive plants has established at Kent Island.

Coastal marsh milk-vetch is proposed for establishment by transplanting cultivated juveniles grown off-site at a native plant nursery under cooperative agreement or commercial contract/work order by qualified individuals (professionals or technically proficient amateur native California plant horticulturists). Seed should be collected from the nearest populations at Drakes-Limantour Estero (White Gate trail salt marsh and southern Drakes Estero sites), with 10 seed sampled from 10 mother plants from at least two separate colonies (total 100 seed). Seed germinate rapidly (< 1 wk in moist sand) in cool, moist conditions in fall-winter weeks after harvest. Seedlings may be inoculated with sand from the base of seed mother plants to ensure wild bacterial and mycorrhizal inoculation for ample root nodule development. Plants should be grown for one spring-summer season in outdoor open beds (no containers or very deep containers with sandy soil to produce unconstrained long taproots) in a cool, maritime microclimate. Plants should be harvested bare-root when shoots are mostly senescent in late fall (November-early December), and when rains have wetted the sand thoroughly at all depths at Kent Island high tide lines. Bare-root transplants should be placed in pits with the full extended length of taproots set with the crown at or slightly below the surface. Sand should be firmly compressed after transplanting to ensure root contact and maximum bulk density of sand. Transplant sites should be limited to identifiable highest tide drift-lines of the previous year around the entire island (sheltered and wave-exposed sites).

7.0 VEGETATION MANAGEMENT UNITS AND PHASED MANAGEMENT ACTIONS

7.1 Vegetation types and management units

Kent Island vegetation can be classified as discrete vegetation management units based on topography, dominant weeds and native vegetation, specific localities of sensitive plant or wildlife species, and corresponding types of weed management and re-vegetation actions indicated. Within each management unit, multiple vegetation types and weed stands occur. Vegetation types are described in Section 2.0. Vegetation management units (VMUs) are shown in Figure 7-1 and Appendix B provides representative photos of each VMU. The principal vegetation management activities and objectives for each VMU are summarized below.

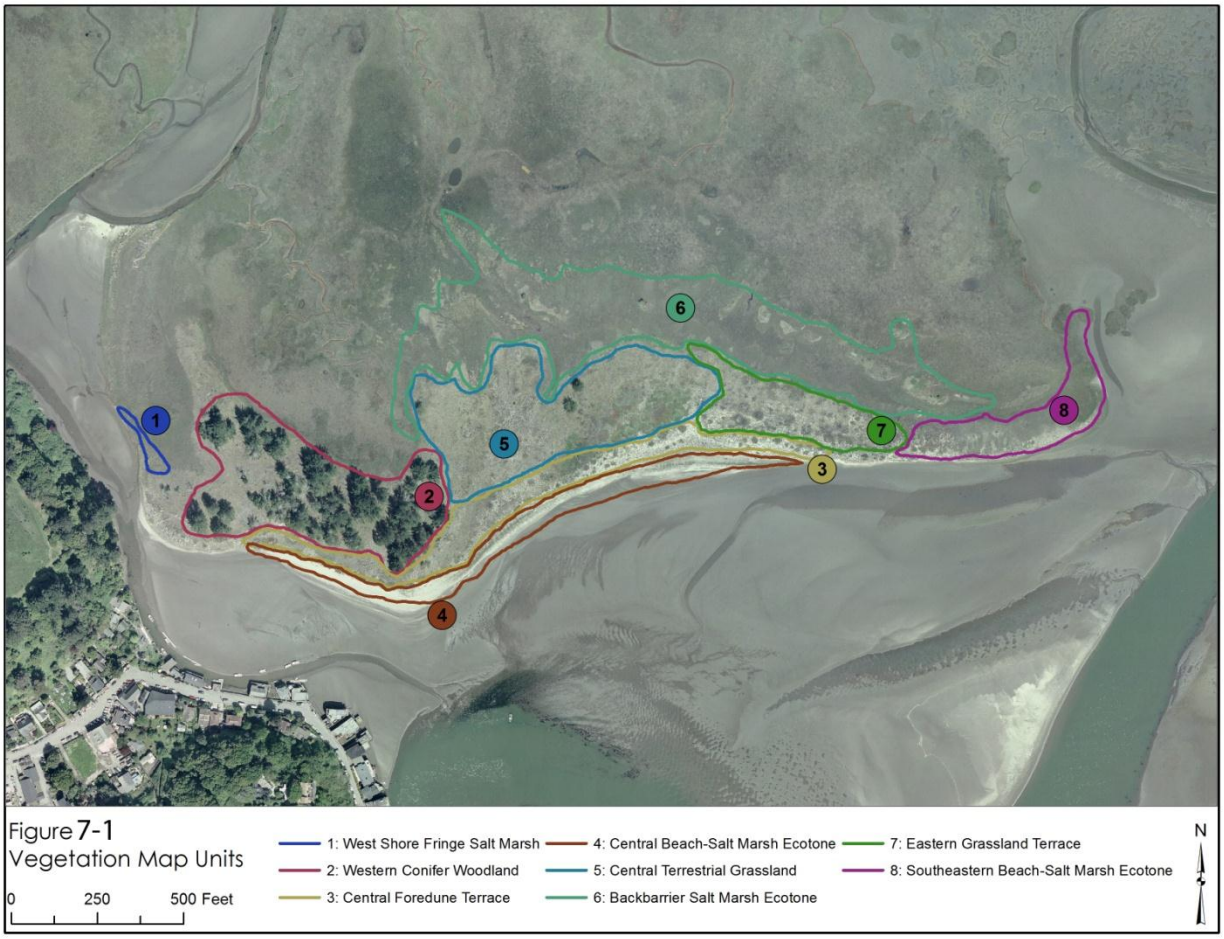

Figure 7-1. Vegetation management Units. (1) West shore fringing salt marsh. (2) Western conifer woodland. (3) Central foredune terrace. (4) Central beach-salt marsh ecotone. (5) Central terrestrial grassland. (6) Backbarrier salt marsh ecotone. (7) Eastern grassland terrace. (8) Southeastern beach-salt marsh ecotone.

7.1.1 West shore fringing salt marsh.

This unit of approximately 0.2 acres consists of the steep, hummocky tidal salt marsh banks between the tidal channel and the stabilized dune grassland with frequent Monterey pine. This unit has only one primary objective: eradication of the extensive colony of rose iceplant in the natural channel bank levee of high salt marsh. This would be completed by applying smothering methods (geotextile fabric/plastic fastened with waste wood, covered with slash piles, or pure slash piles to avoid risk of debris) for one or two growing seasons, and allowing natural re-vegetation by pickleweed, saltgrass, and gumplant to occur in the cleared patch. One rare plant reintroduction is recommended for in this unit: coastal marsh milk-vetch.

7.1.2 Western conifer woodland

This 5.1 acre unit consists of stabilized dune grassland (marram, fescue, wildrye) with a patchy shrub layer (bush lupine, French broom, toyon, coyote brush, and pine saplings) in pine canopy gaps, and predominant pine litter ground layer under the pine canopy. The overstory consists of mature and juvenile Monterey pine trees (with few Monterey cypress) occupied by a seasonal nesting and roosting colony of herons and egrets in the southern most pines. The project does not include the felling or girdling of mature trees while the island supports suitable or occupied heron and egret breeding habitat (see Section 9). Active recruitment of multiple age-classes of pines is evident; decadent, senescent pines will be replaced by younger pines until either rising sea level raises brackish groundwater elevations to lethal levels, or until extreme storm over-wash or co-seismic subsidence events cause mass simultaneous dieback of the entire conifer stand. Minor, low-impact weed management activities are proposed during the non-breeding season as described in the MOU with Audubon Canyon Ranch (Section 9). These include below-ground pruning saw cuts through invasive shrub trunks (bush lupine, French broom), with debris left in place, girdling of pine saplings under three meters in height, and manual pulling of conifer seedlings less than one meter high. These actions would be implemented in the first year. Outlier trees (remote from the heron/egret colony) may be girdled and left as snags. Appendix C provides a Figure and Table of the location, species and DBH of outlier trees to be removed.

7.1.3 Central foredune terrace

This 2.3-acre VMU extends across the south-central shoreline arc between two cuspate shore protuberances that border sand flats exposed to refracted waves that enter Bolinas Lagoon. This unit has the most active wind-transport of sand. Above the erosional foredune scarp and gently prograding (building seaward) foredunes, vegetation is predominantly Vancouver ryegrass, saltgrass, red fescue, and iceplant, with large stands dominated by marram grass or iceplant, displacing native grasslands. Some infrequent but significant conifer saplings are also invading this grassland. Principal tasks for this unit are removal of marram and iceplant-dominated patches, and removal of all conifer seedlings. Recommended removal methods are saline irrigation and smothering, preceded by clonal fragmentation. Manual removal of lower-density stands of marram and iceplant is also recommended. Conifer seedling and sapling removal will require ongoing maintenance as long as the trees and/or seeds remain.

7.1.4 Central beach-salt marsh ecotone

This 1.9-acre arcuate-seaward vegetated beach terrace is dominated by saltgrass and associated native salt marsh forbs at the seaward end of the gradient, grading into terrestrial grassland with large, thick stands of iceplant. Robust colonies of bird's-foot trefoil also occur in areas created by former wrack deposits in this ecotone. Marram stands also occur in this unit. Red fescue, Vancouver wildrye, and beach wildrye compose most of the grassland at the landward of the ecotone. The principal management activities include removal of the dense, consolidated iceplant stands and marram by smothering or seawater irrigation preceded by clonal fragmentation, and manual removal or seawater irrigation. Bird's-foot trefoil would be removed manually with mattocks. Conifer saplings would be removed by pruning saw. Re-vegetation with both dominant and infrequent native species may be indicated in some large patches of iceplant with high residual organic matter (potential weed re-invasion sites). Two rare plant reintroductions are recommended for this unit: coastal marsh milk-vetch and north coast pink sand-verbena.

7.1.5 Central terrestrial grassland (relict washover)

This 5.4 acre VMU occurs north (landward) of the central beach-salt marsh ecotone to the edge of salt marsh. Vegetation here is highly diverse, including a matrix of terrestrial grassland, stabilized marram dune, iceplant patches and diffuse senescent iceplant, widespread conifer saplings and seedlings with a few isolated mature conifers, and stands of French broom and wattle. Fennel also occurs in the grassland. The landforms suggest depositional origins as multiple washover fans modified by former wind deflation and accretion, now relict and stabilized by vegetation. No active dune processes occur today. Isolated non-tidal swale depression wetlands (freshwater to slightly brackish) dominated by coast rush and silverweed are present. Principal vegetation management activities include: removal of all conifers (girdling or felling mature trees, cutting saplings, pulling seedlings); cut-stump or frill herbicide treatment of wattles (alternative: intensive seawater irrigation 2 consecutive years); seawater irrigation or smothering of discrete iceplant and marram patches; and manual removal of fennel and French broom.

7.1.6 Backbarrier salt marsh ecotone

The backbarrier salt marsh ecotone (9.3 acres) occurs along the north shore of the island, where gently sloping deflated washover flats and chains of low sand ridges and mounds grade into tidal marsh. The belt of ridges and mounds encloses and isolates salt marsh with depressions and poor drainage. This VMU has high density to diffuse, extensive and inconspicuous populations of two rare salt marsh annual hemiparasites - northern salt marsh bird's-beak and salt marsh owl's-clover. These populations occur in the upper salt marsh and extend to the lower zones of mounds and ridges. Extensive colonies of bird's-foot trefoil and iceplant occur along the ecotone and in the depressions of the grassland, but this area is mostly native shrubs with patches of fennel. Principal vegetation management actions include seawater irrigation or smothering of discrete iceplant and marram patches; manual/mattock removal of bird's-foot trefoil (and seawater irrigation treatment if feasible; seawater intake shores are remote from the backbarrier shoreline) in late summer/early fall (avoiding impacts to salt marsh annuals); and fennel removal by hand.

One rare plant reintroduction is recommended in this unit: coastal marsh milk-vetch. Additionally, local seed translocation of northern salt marsh bird's-beak and salt marsh owl's-

clover is recommended in suitable unoccupied microhabitats (including bird's-foot trefoil removal patches on mounds).

7.1.7 Eastern grassland terrace

The long, relatively flat terrace of 2.2 acres occupying the eastern end of the island is predominantly native fescue grassland with extensive, low-vigor populations of iceplant, and intermittent large, dense iceplant patches. Native wildrye and saltgrass is relatively infrequent in most of this grassland vegetation. Fennel and bird's-foot trefoil are also widespread in the eastern grassland VMU, but overall, this end of the island has relatively low weed abundance compared with the eastern end. Principal vegetation management actions include seawater irrigation and manual removal of discrete iceplant and marram patches. The extent to which seawater irrigation is used in this relatively dry, unproductive fescue-dominated grassland would depend on the severity of observed fescue dieback after initial trials of seawater irrigation. If post-treatment fescue dieback is strong, and existing populations of iceplant are sparse, tolerance of low iceplant density and cover may be acceptable, rather than high-impact salinization treatment or labor-intensive manual removal. Manual/mattock removal of fennel and bird's-foot trefoil will occur in late summer/early fall to avoid impacts to salt marsh annuals.

7.1.8 Southeastern beach-salt marsh ecotone

This 1.7 acre VMU is similar to the central beach-salt marsh ecotone, but it is distinguished by sensitive wildlife habitat (seal haul-out) at the extreme east end, and broader zones of dense gumplant in the high marsh. It is also one of the least accessible (longest walking distance from the most feasible boat landing sites) of the island's VMUs. Iceplant stands are also widely distributed here. Seawater irrigation is proposed as the primary vegetation management action to reduce iceplant abundance.

Two rare plant reintroductions are recommended for in this unit: coastal marsh milk-vetch and north coast pink sand-verbena. Pink sand-verbena would be introduced primarily in the remaining pocket beach cut into the shoreline that is otherwise dominated by saltgrass-pickleweed salt marsh.

8.0 SCHEDULE OUTLINE OF VEGETATION MANAGEMENT TASKS

The expected start date for Vegetation Management is winter 2012. Prior to active management, the project will complete pre-treatment and control baseline sampling and establish monitoring plots. The MCOSD has also prepared a monitoring design plan.

A schedule of vegetation management tasks is outlined below.

Propagation and seed collection of selected native species

- Summer seed collection prior to start of weed treatment
- Off-site collection of pink sand-verbena and coast marsh milkvetch
- On-site collection of salt marsh owl's-clover within 0.5 meter of weed treatment locations in terrestrial-salt marsh ecotone

- On-site collection of california saltbush seed
- Off-site nursery propagation of coast marsh milkvetch

Winter 2012-2013

- Annual (mattock, pulling) removal of iceplant, fennel, bush lupine, trefoil
- Shrub felling
- Girdling, felling of isolated cypress, pine saplings and trees outside rookery; slash relocation for mulch treatments
- Mulch rose iceplant (salt marsh) – marram thatch, cypress slash
- Compost iceplant wastes on-site for second year transplants
- Removal or girdling of understory conifer saplings (non-nesting season)

May-August Treatments 2013

- Vegetation sampling (post-treatment and control plots)
- Saline irrigation of iceplant and marram
- Full-scale saline irrigation of low-density iceplant stands in terrestrial and ecotone sites
- Manual (mattock, pulling) removal of re-sprouting patches of iceplant, fennel, bush lupine, trefoil
- Weed seedling, survivor, and re-sprout search and removal in first-year treatment areas
- Collect seed of local salt marsh bird's-beak and owl's-clover for winter sowing

Late fall-winter 2013-2014

- Division and transplanting of Vancouver wildrye, beach wildrye, and fescue in treatment areas (depending on sufficiency of spontaneous regeneration – monitoring results)
- Resow & transplant pink abronia, coastal marsh milkvetch, California saltbush
- Sow salt marsh bird's-beak and owl's-clover for winter sowing in selected treatment areas

May-August 2014

- Repeat vegetation sampling (post-treatment and control plots)
- Weed seedling, survivor, and re-sprouts with search & removal in second-year treatment areas
- Collect seed local salt marsh bird's-beak, owl's-clover for winter sowing

Late fall-winter 2014-2015

- Re-sow salt marsh bird's-beak, owl's-clover for winter sowing in selected treatment areas

2015-2018

- Repeat vegetation sampling (post-treatment and control plots)
- Weed seedling, survivor, and re-sprout with search & removal - general (ongoing management)

9.0 POTENTIAL IMPACTS AND BEST MANAGEMENT PRACTICES

9.1 Special Status Species

Bolinas Lagoon supports a diverse ecological community and is designated a Wetland of International Importance under the Ramsar Convention of 1987. It is particularly valuable habitat for fish, shorebirds and waterfowl that use the channels, tidal flats, and vegetated marsh areas of the lagoon, including the area surrounding Kent Island. Kent Island itself provides habitat for several known and potential occurring special status plants and animals. Specific surveys have been conducted for special status and rare plants on the island along with general floristic surveys. No systematic inventory of wildlife has been performed for Kent Island specifically, although numerous biological studies and reviews have been conducted on the lagoon including those associated with planning documents such as the Bolinas Lagoon Management Update (MCOSD 1996), the Bolinas Lagoon Ecosystem Restoration Project Draft Feasibility Study and DEIR/S (ACOE 2002), and the Bolinas Lagoon Ecosystem Restoration Feasibility Project: *Projecting the future of Bolinas Lagoon* (MCOSD 2006). The potential and known occurrence of special status plants (Table 3-1) and animals (Table 9-1, Appendix D) comes from project specific surveys and from lists compiled from U.S. Fish and Wildlife Service (USFWS) species lists (USFWS 2012), California Natural Diversity Database (California Department of Fish and Game (CDFG) 2012) for the U.S. Geologic Survey Bolinas Quadrangle, and from planning documents and studies associated with the Bolinas Lagoon Ecosystem Restoration Feasibility Study (U.S. Army Corps of Engineers draft Feasibility Study and EIR/S 2002) and *Projecting the Future of Bolinas Lagoon* (MCOSD 2006). The lagoon and surrounding area supports a wide array of special status species (Appendix D) but relatively few occur in the Island or in close enough proximity to be affected by the proposed actions (these later species are high-lighted in grey in Appendix D and listed in Table 9-1).

Heron Rookery

The MCOSD and Audubon Canyon Ranch (ACR) have a signed Memorandum Of Understanding (MOU) that outlines measures to avoid impacts to the heron and egret nest sites and to conserve the primary stand of conifers on the island that provide suitable nesting and fledgling habitat for great blue herons and great egrets. Figure 9-1 shows this area and the locations of the heron and egret nest sites in March 2012 (these same sites were used in 2011). Within the main stand of conifers, MCOSD will remove non-native beach grass, ice plant, acacia, pine and cypress seedlings, and other invasive plants from ACR property, subject to the following conditions:

Table 9-1. Special Status Fish and Wildlife that may occur on Kent Island or may be impacted by Vegetation Management Actions.

Birds		
Great egret (rookery) *Ardea alba*		**Present.** Rookery site at Audubon Canyon Ranch and across Bolinas Channel from Kent Island.
Great blue heron (rookery) *Ardea herodias*		**Present.** Rookery at ACR and in the pines on Kent Island and across Bolinas Channel on the mainland.
Northern harrier *Circus cyaneus*	CSC	**Present.** Forages on Island. May possibly nest on Island on ground in grasslands, swales and shrubs but not recorded.
White-tailed Kite *Elanus leucurus*	CFP	**Present**. Forages on Kent Island. Could nest in pines or cypress on Island (follows vole outbreaks) but no records.
Short-eared Owl *Asio flammeus*	CSC	**Present (non-breeding).** Uncommon, sporadic but observed in winter on Kent Island. Roosts in the dunes on Kent Island. Breeds in salt- and freshwater marshes and grasslands. No breeding records.
Western snowy plover *Charadrius alexandrinus nivosus*	FT, CSC	**No recent occurrence** on Kent Island. Nests on sand spits, dune-backed beaches, beaches at creek and river mouths, and salt pans at lagoons and estuaries. Project may improve habitat value for nesting plovers.
Allen's hummingbird *Selasphorus sasin*	FSC	**Potential.** Could breed on Island in the denser shrubs and trees on the Island.
Fishes		
Pacific lamprey *Lampetra tridentata*	FSC	**Present.** CDFG surveys in 1994-96 found lamprey ammocoetes in Pine Gulch Creek. May therefore occur in migration near water intake.
Coho salmon-central CA coast ESU *Oncorhynchus kisutch*	FT, SE	**Present.** Spawns in Pine Gulch Creek and smolts therefore may occur in the Lagoon near the water intake.
Steelhead-central CA coast ESU *Oncorhynchus mykiss*	FT	**Present.** Spawns in Pine Gulch Creek and possibly other Lagoon creeks. Smolts therefore may occur in the Lagoon near the water intake.
Invertebrates		
Bumblebee scarab beetle *Lichnanthe ursina*	FSC	**Potential.** Inhabits coastal dunes. No records from site. Project could provide improved habitat conditions.
Sandy beach tiger beetle *Cicindela hirticollis gravida*	FSC	**Potential.** Inhabits broad tidal beaches. Project could provide improved habitat conditions for this species

*** Key to status codes:**
Status codes used above are:
FE - Federal Endangered
FT - Federal Threatened
FC - Federal Candidate
FPD - Federal Proposed Delisted
FSC - United States Fish and Wildlife Service Federal Species of Concern
NMFS - Species under the Jurisdiction of the National Marine Fisheries Service
SE - State Endangered
CSC - CDFG Species of Special Concern, CSC (Draft) - 4 April 2001 Draft
CDFG Species of Special Concern
CFP - California Fully Protected Species
SLC - Species of Local Concern
None - No status given but rookery sites are monitored by CDFG
List 1B - CNPS 1B List, Endangered, Threatened, or Rare in California List 2- CNPS List 2 Plants are rare, threatened, or endangered in California, but more common elsewhere

1. If ACR biologists deem that removal of invasive plants in the understory of the primary grove of trees significantly reduces fledgling cover for herons, suitable native plants will be planted to provide lost habitat value.

2. Vegetation removal and other restoration work on ACR property shall be conducted after the heron nesting season.

3. All individuals engaging in removal of non-native vegetation on ACR property shall be given training in plant identification in order to prevent removal of native vegetation.

4. All vegetation removed from ACR property shall be disposed of consistent with current best management practices.

In addition to these measures, the project does not include removal of mature trees from the portion of the main conifer grove that occurs on MCOSD land and it establishes a buffer zone of 100 meters around the active nest sites during the breeding season. As part of the project, MCOSD has identified a worker access path through the center of the grove that avoids the buffer zone and other sensitive habitats (Figure 9-1).

Seal Haul Out

Harbor seals use sand bars on the east tip of Kent Island to haul out and pupping sites. Surveys in May 2006 found a high pup count of 174 and a peak molt count of 448 in July on the lagoon. Due to Bolinas Lagoon's close proximity to Highway 1, the seals experience a high rate of disturbance, primarily caused by humans in non-motorized boats and on foot. Allen *et al.* (1984) found that almost all disturbances by people on foot were within 100 meters, but the seals were disturbed at greater distances by non-motorized boats. To avoid disturbing the seals, a 100 meter buffer will be established when seals are hauled out.

Coho and Steelhead

There are several streams that drain into Bolinas Lagoon that support spawning coho salmon and steelhead trout. The lagoon also provides habitat for coho salmon and steelhead trout smolts. Both of the species are protected by federal and state endangered species acts and Bolinas Lagoon is part of the Evolutionary Significant Units for both species. Other special-status fish present in the lagoon include Pacific lamprey-- CDFG surveys in 1994-96 found lamprey ammocoetes in Pine Gulch Creek. To minimize potential impacts to these species, MCOSD will place the water intakes in a 24-inch perforated culvert set vertically in the tidal flat and wrapped with fish screen (3/8 inch or smaller) and the maximum pumping rate would be 160 gallons per minute (gpm). To avoid inadvertent de-watering of adjacent pools, clogging or other malfunction of the fish screen, MCOSD will monitor the intakes.

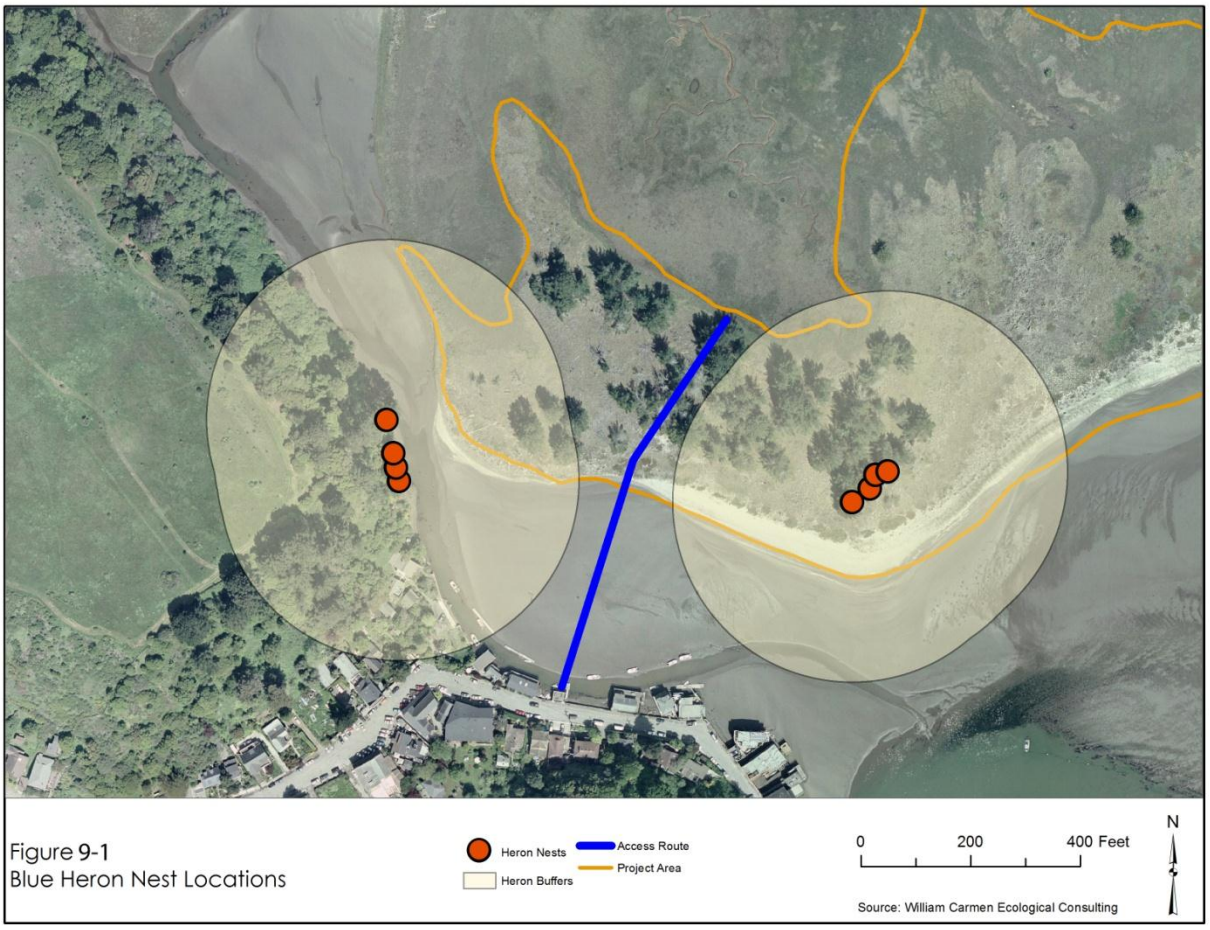

Figure 9-1. Small red circles indicate approximate nesting locations of great blue herons and great egrets in 2011 and 2012. The shaded areas show a 100-meter buffer area around the nest locations where activity will be limited during the heron nesting season. The College of Marin dock will be used to provide access to the island. The blue line illustrates the worker pathway through the island.

Other Wildlife

Prior to vegetation treatment, MCOSD will conduct surveys for bird nesting activities on the island. If the surveys identify an active nest, the following measures would be implemented:

- Establish a 100-foot buffer around active raptor nests.
- Establish a 50-foot buffer around active nests of other bird species.

No vegetation management activities shall be allowed within the buffer zone until one of the following conditions has been met:

- The young have fledged from the nest.

- The birds abandon the nest on their own.
- The nest fails and the birds do not re-nest.

In the 1970s, the lagoon supported approximately 25 wintering snowy plovers. However, their numbers have declined, and by the 1990s, the plover appeared not to be using the lagoon. However, in 2007, the Point Reyes Bird Observatory documented a small number of plovers wintering at the lagoon (PRBO 2007). Breeding plovers have not been recorded at the lagoon since the 1980s.

Small mammals that may occur in and adjacent to the lagoon include voles, deer mice and several species of shrews. The island has considerable rack (logs, plywood, lumber, and other debris) that provides refugia and nest sites for small mammals such as California voles and deer mice. The rack also provides cover for alligator lizards on upland areas. One seasonal wetland depression (dune slack) dominated by Baltic rush and silverweed occurs within the upland portion of the island and one tree frog call was detected in fall 2011. The project does not include weed removal within this seasonal wetland.

There are two special-status invertebrates that could potentially occur on the island – a bumblebee scarab beetle and a sandy beach tiger beetle. The former may occur in the upland area of the island, as the larvae live in burrows in sandy areas and feed on decaying leaf litter and detritus in the sand. The sandy beach tiger beetle burrows on broad sandy beaches with adults in the zone between the high-tide line and the dunes and the larvae inhabiting burrows in the upper tidal zone. Qualified field biologists will inspect the island to detect the presence of these species. If detected, MCOSD will modify the project to avoid their habitat.

Plants

Section 3.0 includes a complete discussion of rare plants on Kent Island and vicinity.

9.2 Defined Pathway Access

As part of the pre-project activities, a qualified plant biologist will identify and flag populations of sensitive plants. In addition, the biologist will identify a pedestrian route that will provide access to treatment and monitoring sites and avoid impacts to sensitive plant populations.

9.3 Equipment

The irrigation system will be powered by a small gasoline high pressure pump capable of pumping 160 gpm, whose noise level is limited to 80 dB (as certified by the California Air Resources Board and the federal Environmental Protection Agency). The pump will be housed in a set of sound containment boxes to reduce noise as shown in Figure 9-2. The intake would be placed within a 24-inch diameter culvert set vertically in the sand of the tidal flat to a depth of two to three feet. The pipe would be perforated and wrapped with fine (3/8”) fish screen. The pipe would extend above high water and the intake hose from the pump placed inside (Figure 9-3).

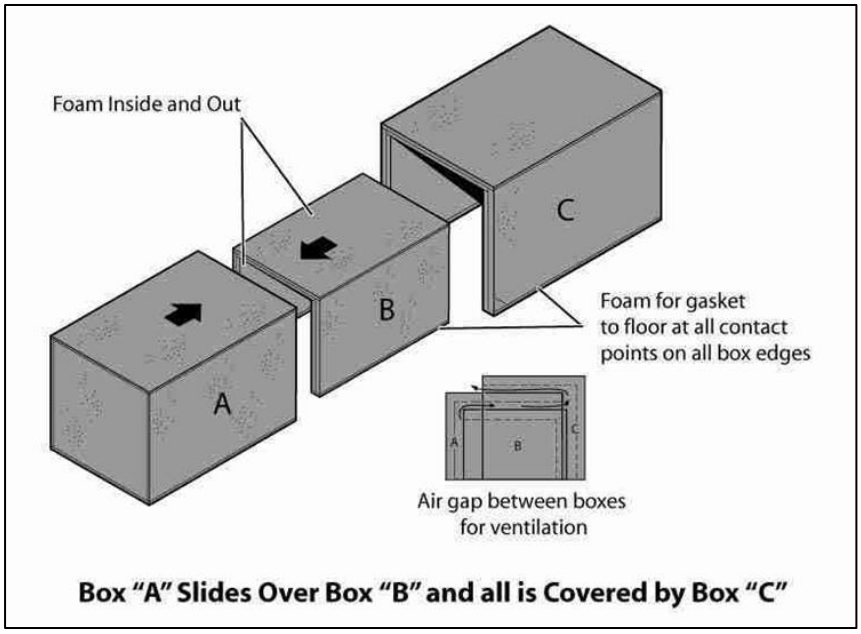

Figure 9-2. An example of a sound attenuating system to house the water pump. Enclosures are made of fiberboard lined with 2-inch thick sound proofing mat with a one inch gap between the inner and outer boxes for air circulation. Modified from the EPA Manual, "QUIETING: A Practical Guide to Noise Control".

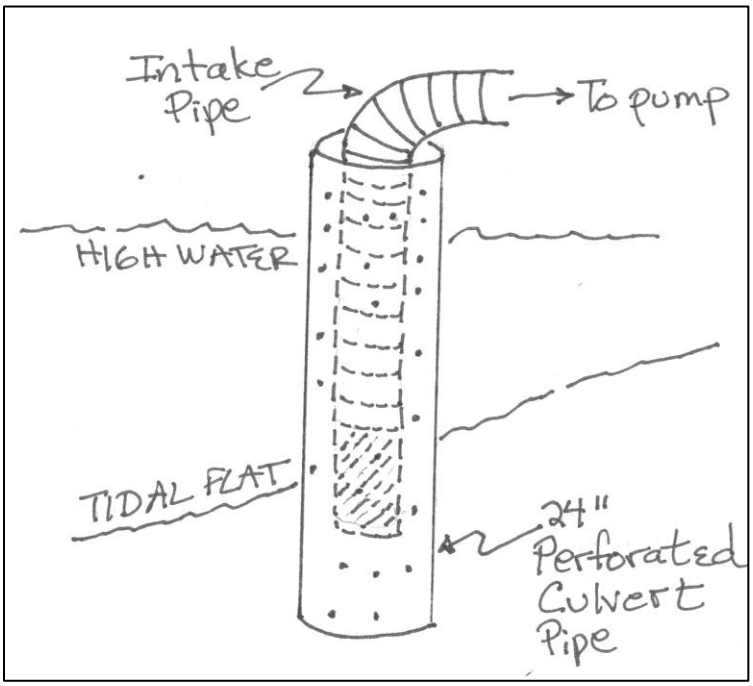

Figure 9-3. **The Water Intake System**. A 24-inch perforated culvert pipe is wrapped with fine screen and set vertically two feet into the tidal channel.

The pump must be positioned within approximately 20 feet of the water intake. Figure 9-4 shows the two proposed locations for the intakes — the primary location is on the northwest corner of the island away from the motorized boat, residential areas, and the heron nesting areas. The secondary intake will be on the south shore of the island (Figure 9-4) in an area not used by motorized boats and outside the heron buffer zone.

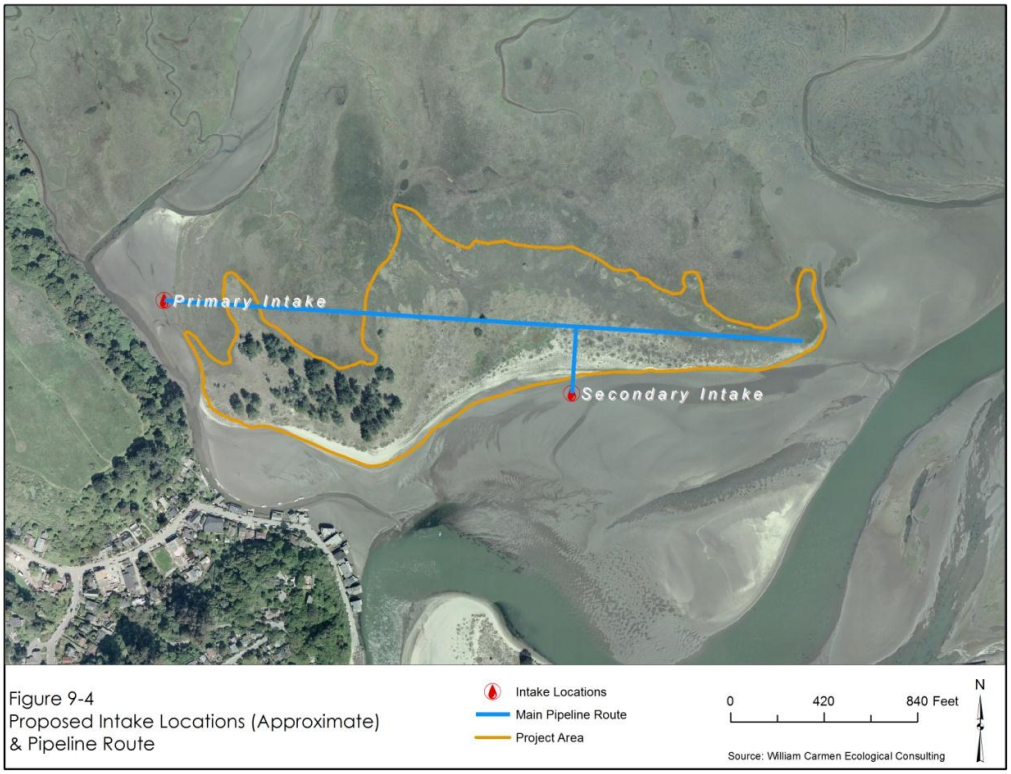

Figure 9-4. Primary and secondary water intake and pump locations.

The pump outflow would be connected to a three-inch mainline pipe that would bisect the island from roughly west to east (Figure 9.4). Valves at appropriate locations on the mainline will allow connection to a single high-volume portable sprinkler or several large hand-held hoses that can quickly inundate treatment areas. Floristic and rare plant surveys in spring and early summer will determine the areas within the VMUs appropriate for salt water irrigation. The amount of irrigation necessary within a designated treatment area will depend on sand moisture content and the depth and amount of organic cover material but in general three to five inches of irrigation on moist sand would be required to wet the whole root system.

9.4 Water Quality

In order to avoid water quality impacts from accidental fuel spills, MCOSD will place the saltwater irrigation pump in a plastic or metal basin, inside the sound attenuating box (see below). No fuel will be stored on the island. It will be transported on to the island as needed. In addition, a fuel spill clean-up kit (oil only absorbent pads for use on land or water, shovel, five-gallon plastic cans, absorbent kitty-litter, plastic garbage bags) will be kept at the pump site and while

transporting fuel boat to the island. Any herbicides used for the project will be stored and mixed at an offsite location and transported in no more than one quart quantities.

9.5 Aesthetics and Sound

In order to minimize aesthetic impacts from the project, the temporary staging areas, vegetation disposal areas will be sited in less visible areas. In addition, as described above, the pump will be sited away from heron and egret nest sites, housed a double-lined sound attenuation box to reduce noise level, and its operation limited to weekdays between 8:00 a.m. and 5:00 p.m.

9.6 Vegetation Disposal

Manual removal of plants that may potentially regenerate requires temporary stockpiling and final disposal. Tarps will be placed below and above stockpiled debris, treated to reduce viability of live debris, self-shading and composting, or saline irrigation. Final disposal of debris will occur on-site (to avoid impacts of hauling and staging barges), in pits dug to depths below the depth at which degenerated plant debris disposed would be likely to regenerate (0.5 meter cover, monitored for re-sprouts).

9.7 Worker Access, Numbers and Training

Workers will access the island from the College of Marin boat dock on Wharf Road in Bolinas (Figure 9-1). The island can be accessed by kayak or rubber raft. At very low tide, it is possible to walk across the channel. The work will be accomplished with both paid and volunteer staff, but no more than 25 people will be on the island at one time. The number of volunteer days is expected to be highest during the first year of implementation and decline during the subsequent five-year monitoring period. Volunteer participation is dependent on the success of initial treatment, the persistence of established plants, and rate of re-colonization/recruitment of new individuals. Volunteers will be trained to avoid disturbance to wildlife and rare plants, use appropriate vegetation removal and re-vegetation practices, and identify non-native plants. Volunteers will use only hand tools (hand saws, pruners, shovels, and mattock).

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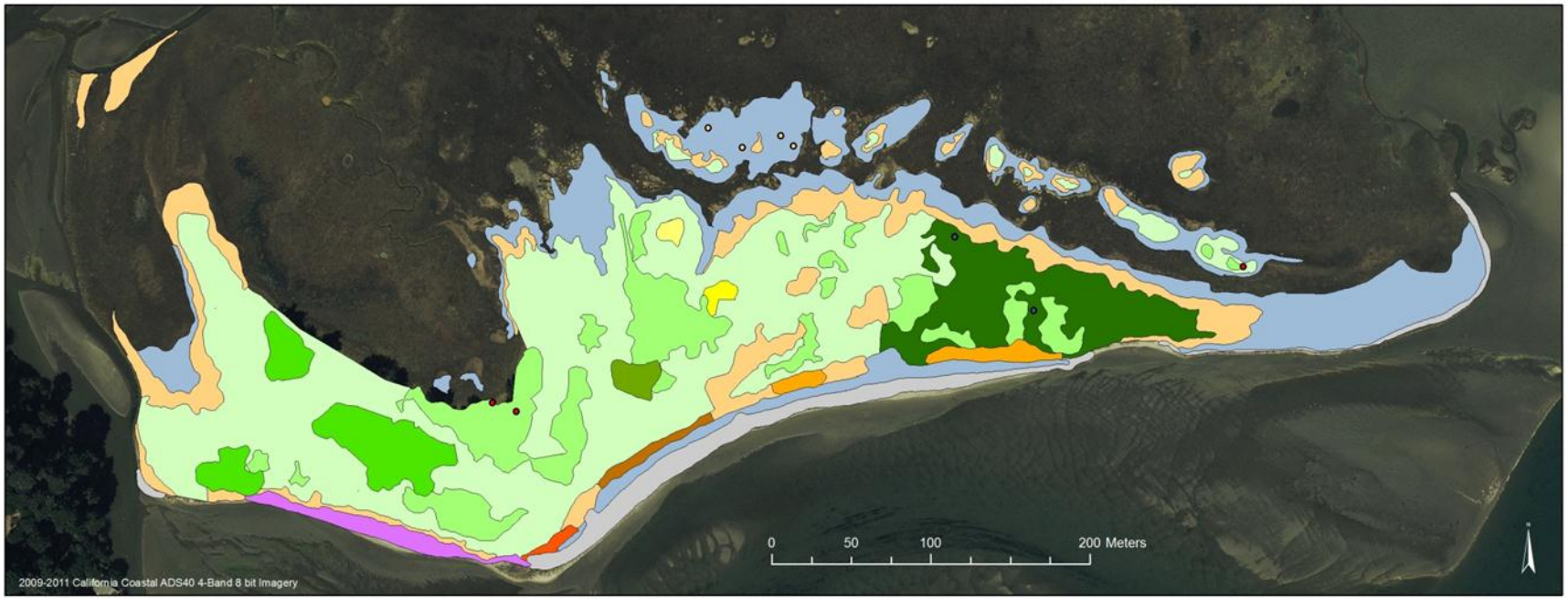
APPENDIX A



Kent Island

Plant Communities
June 2012

Legend

Plant Community

- Cakile maritima
- Distichlis spicata
- Festuca rubra-Carpobrotus edulis
- Festuca rubra-Carpobrotus edulis/Ammophila arenaria
- Festuca rubra-Carpobrotus edulis/Artemesia pycnocephala
- Festuca rubra-Carpobrotus edulis/Elymus x vancouveriensis
- Festuca rubra-Carpobrotus edulis/Soil
- Grindelia stricta
- Grindelia stricta-Carpobrotus edulis
- Grindelia stricta-Carpobrotus edulis/Elymus mollis
- Grindelia stricta-Carpobrotus edulis/Elymus x vancouveriensis
- Juncus balticus
- Juncus balticus-Carpobrotus edulis
- Plantago maritima

Non-target Species

- Grindelia stricta var. angustifolia
- Heteromeles arbutifolia
- Salix lasiolepis

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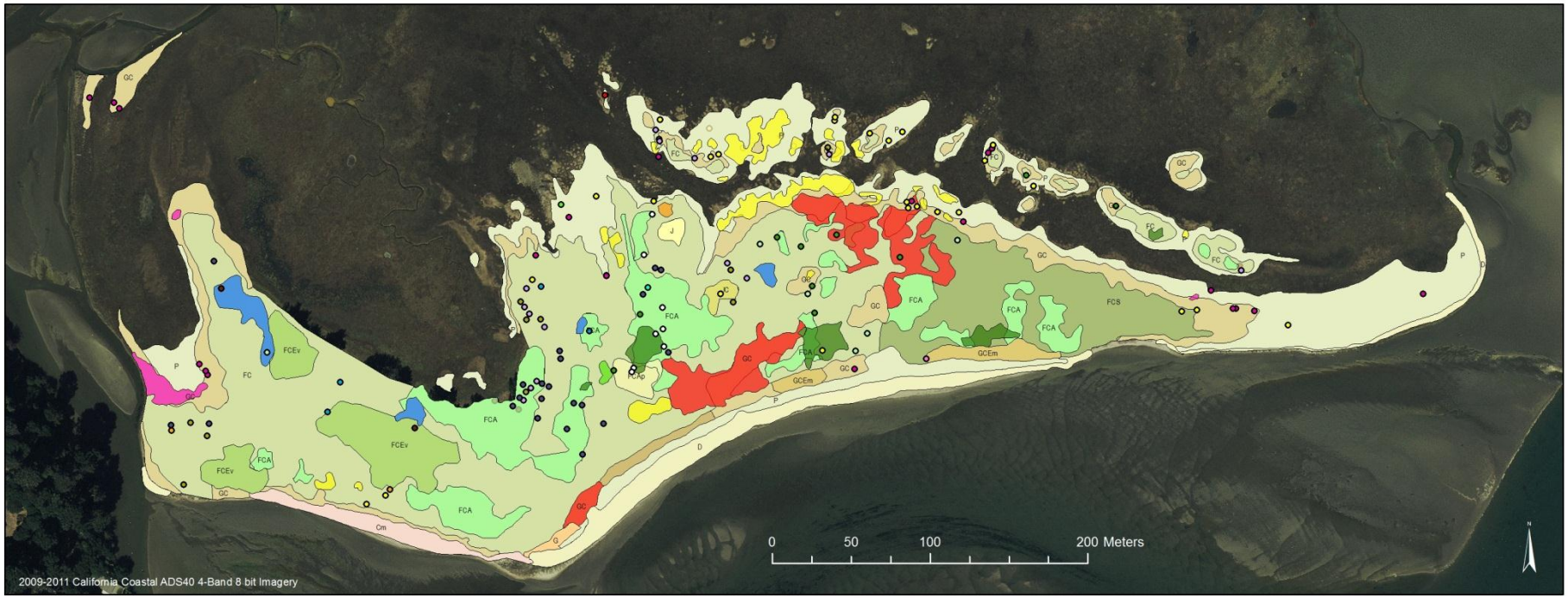

Kent Island

Target Species June 2012

Legend

Target Species

- Ammophila arenaria
- Carpobrotus edulis (co-dominant)
- Carpobrotus edulis (dominant)
- Drosanthemum floribundum
- Foeniculum vulgare
- Genista monspessulana
- Lotus corniculatus
- Lupinus arboreus
- Melilotus indica
- Non-target Plant Communities

Target Species

- Acacia longifolia
- Ammophila arenaria
- Carpobrotus edulis
- Cotoneaster pannosus
- Cytisus scoparius
- Drosanthemum floribundum
- Foeniculum vulgare
- Genista monspessulana
- Hesperocyparis macrocarpa
- Limonium ramosissimum
- Lotus corniculatus
- Lupinus arboreus
- Melilotus indica
- Pinus radiata
- Pseudotsuga menziesii

Plant Community Codes

Cm	Cakile maritima
D	Distichlis spicata
FC	Festuca rubra-Carpobrotus edulis
FCA	Festuca rubra-Carpobrotus edulis/Ammophila arenaria
FCAp	Festuca rubra-Carpobrotus edulis/Artemesia pycnocephala
FCEv	Festuca rubra-Carpobrotus edulis/Elymus x vancouveriensis
FCS	Festuca rubra-Carpobrotus edulis/Soil
G	Grindelia stricta
GC	Grindelia stricta-Carpobrotus edulis
GCEm	Grindelia stricta-Carpobrotus edulis/Elymus mollis
GCEv	Grindelia stricta-Carpobrotus edulis/Elymus x vancouveriensis
J	Juncus balticus
JC	Juncus balticus-Carpobrotus edulis
P	Plantago maritima

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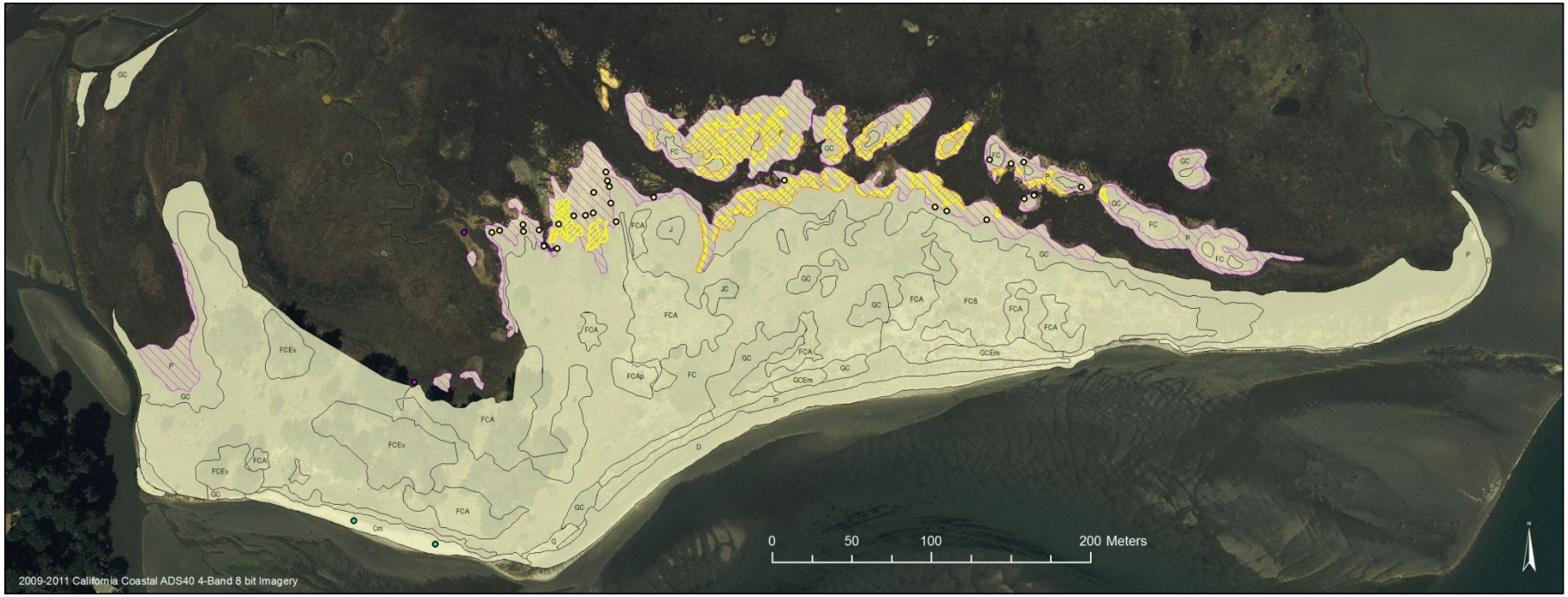


Kent Island

Rare Plants
June 2012

Legend

Plant Communities

Rare Plants

Castilleja ambigua ssp. ambigua

Chloropyron maritimum ssp. palustre

Abronia umbellata var. breviflora

Castilleja ambigua ssp. ambigua

Chloropyron maritimum ssp. palustre

Plant Community Codes

Cm	Cakile maritima
D	Distichlis spicata
FC	Festuca rubra-Carpobrotus edulis
FCA	Festuca rubra-Carpobrotus edulis/Ammophila arenaria
FCEv	Festuca rubra-Carpobrotus edulis/Elymus x vancouveriensis
FCS	Festuca rubra-Carpobrotus edulis/Soil
G	Grindelia stricta
GC	Grindelia stricta-Carpobrotus edulis
GCEm	Grindelia stricta-Carpobrotus edulis/Elymus mollis
GCEv	Grindelia stricta-Carpobrotus edulis/Elymus x vancouveriensis
J	Juncus balticus
JC	Juncus balticus-Carpobrotus edulis
P	Plantago maritima

Created by: Shelly Benson, Contact information: shelly.benson@yahoo.com, 707-479-6777

APPENDIX B

Kent Island vegetation management units: representative vegetation stands

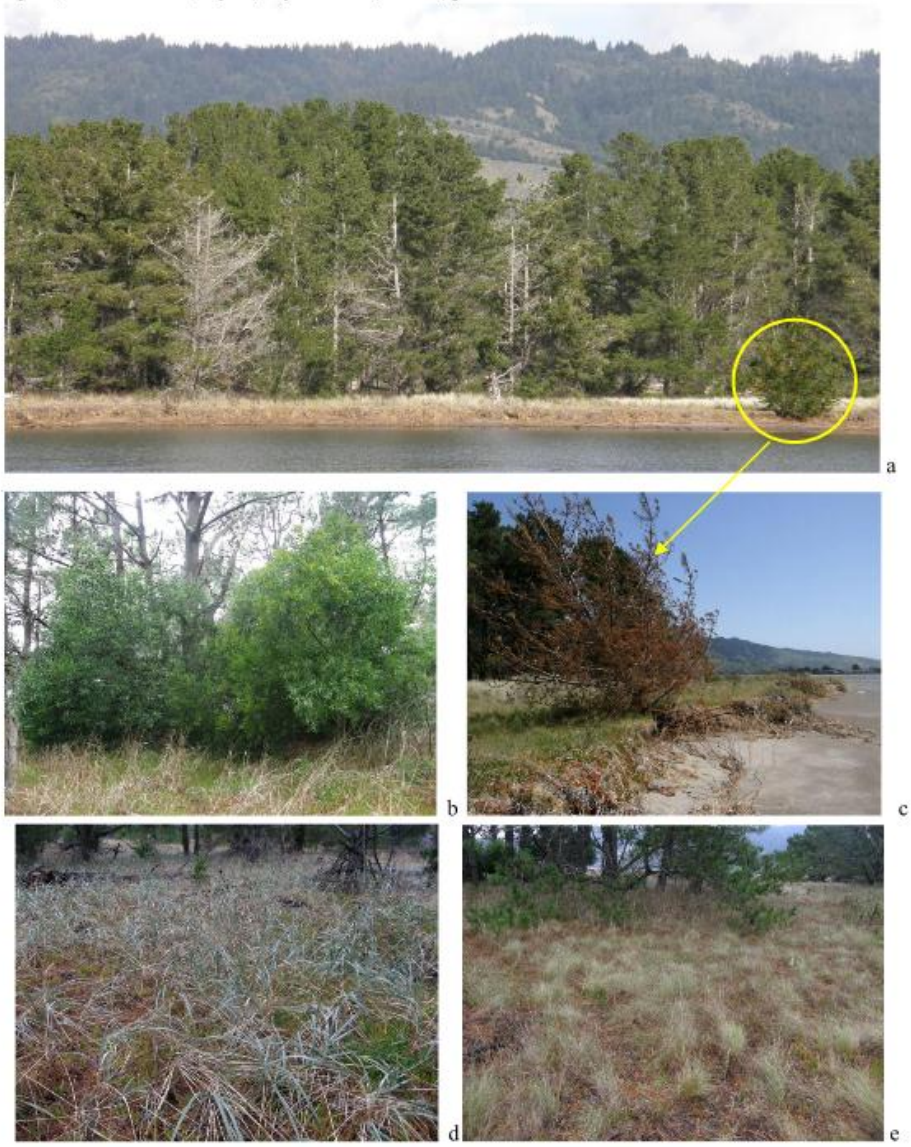
1 West shore fringing salt marsh. Steep, hummocky tidal salt marsh banks with extensive colony of rose iceplant (*Drosanthemum floribundum*) in the natural channel bank levee of high salt marsh.

a

b

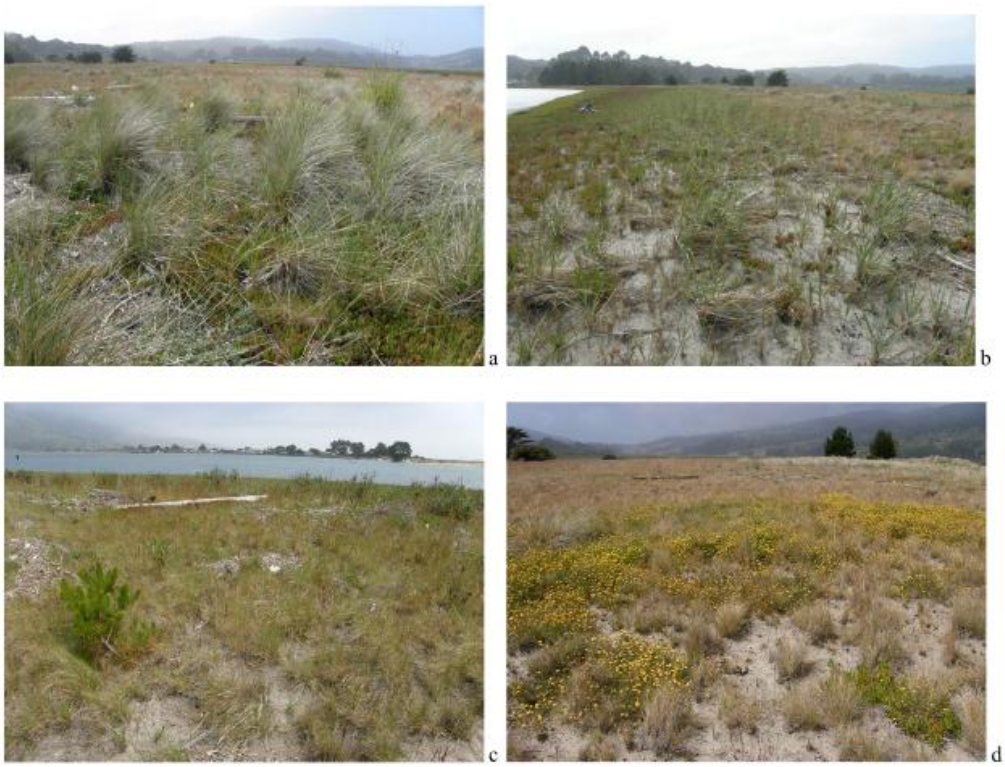
(a) Rose iceplant dominates large patches of high salt marsh on natural levees, displacing gumplant, pickleweed, alkali-heath, sand-spurrey, and saltgrass vegetation, November 2011. (b) Rose iceplant in bloom on levee high salt marsh, April 2010.

2 Western conifer woodland. Mature and juvenile Monterey pine trees and few Monterey cypress dominant overstory above older stabilized dune grassland (marram, red fescue, wildrye), with a patchy shrub layer (bush lupine, French broom, toyon, coyote brush, acacia, pine



(a) Monterey pine grove, view from west, February 2010. Note dead and decadant trees near erosional retreating shoreline subject to salt water overwash. Circled young tree becomes salt-killed and undermined by erosion, toppled (c) in April 2010. (b) Acacias in canopy gaps. (c) Active erosion and retreat of older stabilized dune grassland buffer around pine grove. (d) Understory of Vancouver ryegrass with red fescue, iceplant, pine seedlings. (e) Red fescue dominant open patch within closed-canopy pine grove.

3 Central foredune terrace. Highest of the low-relief relict foredune topography, with most recent active wind-transport of sand at seaward end. Vegetation is predominantly Vancouver ryegrass, saltgrass, red fescue, and iceplant, with large stands dominated by marram grass or iceplant. Monterey pine and bird's-foot trefoil are also invasive.



(a) Marram and iceplant dominant patch, formed by original stabilization by marram during past active sand transport, followed by iceplant invasion after sand accretion ceased. (b) Vancouver ryegrass dominated relict foredune. (c) Seaward edge of relict foredunes, transition to beach-marsh ecotone, with old storm wrack deposits and pine sapling. (d) Landward end of relict foredunes, transition to central stabilized terrestrial grassland, exhibiting local heavy invasion by bird's-foot trefoil.

4 Central beach-salt marsh ecotone. Vegetated beach terrace subject to recent storm overwash, sand deposition, erosion, and seawater flooding in winter, dominated by saltgrass and associated native salt marsh and beach forbs (including gumplant, California saltbush, whiteleaf saltbush) at the seaward end of the gradient, grading into foredune and terrestrial grassland with red fescue, Vancouver wildrye, and beach wildrye at the landward end of the ecotone. Iceplant, bird's-foot trefoil are invasive throughout the landward, upper end of the ecotone.

(a) Saltgrass-dominated salt marsh expands by creeping rhizomes into intertidal beach, widening the salt marsh zone in the foreground in November 2011; erosion and salt marsh narrowing occurs in background shoreline. (b) Native species-rich sandy high salt marsh with sea-plantain, California saltbush, sand-spurrey, sea-lavender. (c) Older organic storm drift-line deposits invaded by iceplant, nourished by wrack "compost". (d) Older organic storm drift-line deposits dominated by bird's-foot trefoil.(e) Active winter sand overwash deposition in high salt marsh, burying lower-growing species, some of which will later emerge and regenerate; tall gumplant persists. (f) Recent wrack and sand deposition defines landward edge of ecotone.

5 Central terrestrial grassland (relict washover). Highly diverse grassland and forb assemblages derived from stabilization of former washover and foredunes isolated from the southward-shifting shoreline: stands of marram, red fescue, iceplant-dominant patches, grassland with diffuse senescent iceplant, widespread conifer saplings, broadleaf weeds (French broom, acacia, fennel, etc.) and native forbs.


a


b


c


c

(a) Iceplant patch branching into stabilized red fescue grassland, with remnants of old storm drift-line deposits and beach-bur. (b) Monterey pine sapling near old drift-log and drift-lines in matrix of stabilized red fescue grassland. (c) Monterey cypress sapling among marram, iceplant, red fescue. (d) Red fescue flats with colony of bush lupine in background.

6 Backbarrier salt marsh ecotone. Gently sloping, stabilized remnants of old washover flats, with chains of low stabilized sand deflation ridges and mounds, grading into extensive high tidal salt marsh along the back (north shore) of Kent Island. The wave-sheltered salt marsh ecotone supports two rare salt marsh annual hemiparasitic wildflowers, northern salt marsh bird's-beak and salt marsh owl's-clover in the upper salt marsh; these occur in patchy high density to diffuse, extensive and inconspicuous populations. Extensive dense colonies of bird's-foot trefoil invade mounds and stabilized dune edges of the ecotone. Marram and acacia occur on higher old mounds.

(a) Low relict deflation ridge (high salt marsh ecotone) and swale (salt pan); ridge vegetation is nearly pure native salt marsh with high species diversity. (b) Extensive colonies of bird's-foot trefoil (yellow) invade high marsh in wet years, and persist. (c-d) Upper high salt marsh ecotone with frequent, dwarf salt marsh owl's-clover among native salt marsh forbs in areas still unoccupied by bird's-foot trefoil; (f-g) salt marsh bird's-beak in high salt marsh with sea arrow-grass.

7 Eastern grassland terrace. Relatively flat stabilized sand terrace (old washover and beach with minimal relict foredune topography) occupying the eastern end of the island. Vegetation is predominantly native red fescue grassland with extensive diffuse, low-vigor populations of iceplant, bird's-foot trefoil and intermittent large, dense iceplant patches, some marram and Vancouver ryegrass.


a


b

(a) Extensive red fescue grassland stand invaded by bird's-foot trefoil (background, yellow); iceplant sparse and infrequent. (b) Red fescue flats with marram patches on topographic highs (relict dunes).

8 Southeastern beach-salt marsh ecotone. Beach-salt marsh ecotone similar to the central beach-salt marsh ecotone, but distinguished by sensitive wildlife habitat (seal haul-out) at the extreme east end, broader zones of dense gumplant in the high marsh, and persistence (2012) of a relatively wave-sheltered pocket beach. Iceplant stands are also widely distributed here. Two rare local plant reintroductions are recommended for in this unit: coastal marsh milk-vetch and north coast pink sand-verbena. Pink sand-verbena would be introduced primarily in the remaining pocket beach cut into the shoreline that is otherwise dominated by saltgrass-pickleweed salt marsh.

(a) Harbor seal haul-out on high sand flat adjacent to eastern edge of salt marsh. (b) beach-salt marsh ecotone with drift-lines and widespread iceplant. (c) North coast pink sand verbena from a large colony at the east end of Stinson Beach (GGNRA), a rare beach wildflower suitable for reintroduction to Kent Island at the pocket beach (d) at the west end of this vegetation management unit. (e) Drift-line wracks demarcate the transition between regularly flooded salt marsh and storm-flooded high salt marsh ecotone with gumplant, Vancouver ryegrass, and red fescue.

Appendix C

Figure C-1. Location of trees to be killed. Numbers are referenced in below by species and DBH.

Tree Number (see Fig. TREE)	Species	DBH (inches)
1	Monterey Pine	3
2	Monterey Pine	6
3	Monterey Pine	3.5
4	Monterey Pine	3
5	Monterey Pine	2+2 (Twin trunk)
6	Monterey Pine	6
7	Monterey Pine	2.75
8	Monterey Pine	2
9	Monterey Pine	13
10	Monterey Pine	12
11	Douglass Fir	4
12	Monterey Pine	8+10 (Twin trunks)
13	Monterey Pine	5
14	Monterey Pine	1
15	Monterey Cypress	Multiple stems 2 to 4 inches
16	Monterey Pine	1.5
17	Monterey Pine	3 at 3 ft. then multiple splits
18	Monterey Cypress	12+12+12 (multi-trunk)
19	Monterey Pine	16
20	Monterey Pine	1.5
21	Monterey Cypress	12
22	Monterey Cypress	11

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SPECIES	**STATUS***	HABITAT	**POTENTIAL FOR OCCURRENCE (lagoon and vicinity)**	**ON KENT ISLAND and POTENTIAL FOR EFFECT**
Mammals				
Yuma myotis *Myotis yumanensis*	FSC, CSC	From urbanized environments to heavily forested settings. Day roosts in buildings, trees, mines, caves, bridges and rock crevices. Night roosts associated with man-made structures.	**Moderate Potential.** Common and widespread in California. May forage in open forest and woodland habitat in vicinity.	**May forage over Island. No effect.**
pallid bat *Antrozous pallidus*	CSC	Found inwide variety of habitats. Most common in open, dry habitats with rocky areas for roosting. Very sensitive to disturbance of roosting sites.	**Moderate Potential.** Closest occurrence at Olema Creek in riparian vegetation dominated by alders. Similar habitat available at Pine Gulch, northern tip of lagoon.	**May forage over Island. No effect.**
Pt. Reyes mountain beaver *Aplodontia rufa phaea*	FSC, CSC	Occurs near springs or seepages in densely vegetated riparian and scrub areas in the vicinity of Pt Reyes peninsula. Population status unknown.	**Low Potential.** Formerly occurring throughout Pt. Reyes National Seashore. Most populations are now thought to be extirpated.	**None. No suitable habitat on KI. No effect.**
Pt. Reyes jumping mouse *Zapus trinotatus orarius*	FSC, CSC	Occurs in riparian areas, grasslands, and wet meadows of Pt. Reyes peninsula. Population status unknown.	**Low Potential**. Suitable habitat available in Pine Gulch riparian area. Population status uncertain.	**None. No suitable habitat on KI. No effect.**

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Guadalupe fur seal *Arctocephalus townsendi*	FT	Guadalupe fur seals reside in the tropical waters of the Southern California/Mexico region. During breeding season, they are found in coastal rocky habitats and caves.	**Not Present.** Guadalupe fur seals are non-migratory and their breeding grounds are almost entirely on Guadalupe Island, Mexico.	**No effect.**
Steller sea lion *Eumetopias jubatus*	FT	Distributed along coasts to the outer continental shelf along the North Pacific Ocean rim from Japan through the Aleutian Islands and central Bering Sea, southern coast of Alaska and south to California.	Southeast Farallon Island is designated Critical Habitat for this species. Occurs of the coast of Bolinas.	**No suitable habitat in the Lagoon. No effect.**
Sei whale *Balaenoptera borealis*	FE	Prefer subtropical to subpolar waters on the continental shelf edge and slope worldwide. They are usually observed in deeper waters of oceanic areas far from the coastline.	**Not present** in the Lagoon.	**No suitable habitat. No effect.**
Blue whale *Balaenoptera musculus*	FE	Blue whales are found in oceans worldwide.	**Not present** in the Lagoon but occurs offshore.	**No suitable habitat in the Lagoon. No effect.**
Fin Whale *Balaenoptera physalus*	FE	Fin whales are found in deep, offshore waters of all major oceans.	**Not present** in the Lagoon but may occur offshore.	**No suitable habitat in the Lagoon. No effect.**
North Pacific Right Whale *Eubalaena japonica*	FE	Occurred historically in all the world's oceans primarily in coastal or shelf waters.	**Not present** in the Lagoon but may occur offshore.	**No suitable habitat in the Lagoon. No effect.**

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Sperm Whale *Physeter macrocephalus*	FE	Inhabit areas with a water depth of 600 m or more, and are uncommon in waters less than 300 m deep. Sperm whales inhabit all oceans of the world.	**Present** in offshore waters.	**No suitable habitat in Lagoon. No effect.**
Birds				
short-tailed albatross Phoebastria albatrus	*FE*	*Nests on oceanic atolls in Pacific. Very rare along California coast in nonbreeding season.*	**Not present.**	**No effect.**
common loon *Gavia immer*	FSC, CSC	Winter in estuarine and subtidal marine habitats along the California coast, San Francisco Bay.	**Present.** Known to winter in Bolinas Lagoon.	**Winter occurrence in Lagoon. No effect.**
California brown pelican *Pelecanus occidentalis californicus*	FE, SE, CFP	Found in estuarine, marine subtidal, and marine pelagic waters along the coast. Nest on rocky or low brushy slopes of undisturbed islands.	**Present.** Documented to forage in Lagoon; nesting habitat not available.	**Forages in the Lagoon. May use exposed sand bars adjacent to the Island for resting in non-breeding season. No effect.**
double-crested cormorant *Phalacrocorax auritus*	CSC	Nests along coast on sequestered islets, usually on ground with sloping surface or in tall trees along lake margins.	**Present.** Documented to forage in Lagoon.	**Forages in the Lagoon. May use exposed sand bars adjacent to the Island for resting. No effect.**

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great egret (rookery) Ardea alba		Colonial nester in large trees. Rookery sites located near marshes, tide-flats, irrigated pastures, and margins of rivers and lakes.	**Present.** Rookery site at Audubon Canyon Ranch and adjacent to Kent Island.. Forages in Lagoon.	**Occurs in the Lagoon. Began nesting in heron rookery across Bolinas Channel from KI in 2011.**
black-crowned night heron (rookery) *Nycticorax nyticorax*		Colonial nester, usually in trees, occasionally in tule patches. Rookery sites located adjacent to foraging areas: lake margins, mud-bordered bays, marshy spots.	**Present.** Documented to forage throughout Lagoon. No documented rookeries in vicinity of Lagoon	**Forages in the Lagoon but no rookeries. No effect.**
great blue heron (rookery) *Ardea herodias*		Colonial nester in tall trees, cliffsides, and sequestered spots on marshes. Found in close proximity to foraging areas (rivers and streams, tide-flats, wet meadows.)	**Present.** Rookies in vicinity of Inverness, Olema, and the east and north arm of Drakes Estero. Formerly nested at ACR. Nest on Kent Island and across channel on mainland.	**There is a rookery in the pines on KI and across Bolinas Channel on the mainland.**
white-tailed kite *Elanus leucurus*	FSC, CFP	Year-long resident of coastal and valley lowlands; rarely found away from agricultural areas. Preys on small diurnal mammals and occasional birds, insects, reptiles, and amphibians.	**Low Potential.** Suitable breeding and foraging habitat is available in the vicinity but species is not likely to utilize lagoon habitat. May occur as transient.	**Occasional foraging use of KI. No effect.**

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Short-eared Owl *Asio flammeus*		Short-eared Owls are frequent winter visitors and closely tied to rodent abundance. Forage in open meadow grasslands and marshes. Nest sporadically on the coast.	Present. Observed in winter foraging on and around the lagoon. No nest records for the Lagoon vicinity.	**Present (non-breeding).** Observed in winter on Kent Island. Known to roost in the dunes on the Island. Breeds in salt- and freshwater marshes and grasslands. No breeding records.
osprey *Pandion haliaetus*	CSC	Nests along ocean shores, bays, freshwater lakes and larger streams in treetops.	**Present.** Nest along Inverness Ridge and observed foraging over Bolinas Lagoon.	**Forages on Lagoon. No effect.**
northern harrier *Circus cyaneus*	CSC	Frequents meadows, grasslands, rangelands, fresh and saltwater emergent wetlands throughout California. Nests in shrubby vegetation on ground.	**High Potential.** Suitable foraging habitat available in saltmarsh areas. Known to forage and breeds in vicinity	**Forages on Island. May possibly nest on Island but not recorded.**
ferruginous hawk *Buteo regalis*	FSC, CSC	Frequents open grasslands, sagebrush flats, desert scrub, low foothills surrounding valleys and fringes of pinyon-juniper habitats.	**Low Potential**. Uncommon winter resident and migrant at lower elevations. May occur as transient.	**Rare visitor. No effect from Project.**
American peregrine falcon *Falco peregrinus anatum*	FD, SE, CFP	Winters throughout Central Valley. Requires protected cliffs and ledges for cover. Feeds on a variety of birds, and some mammals, insects, and fish.	**High Potential.** Anecdotal evidence of occurrence at Lagoon. Suitable foraging and nesting habitat available.	**May forage on Lagoon. No effect.**

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California clapper rail *Rallus longirostris obsoletus*	FE,SE	Found in tidal marshes of SF Bay. Requires mudflats for foraging and dense vegetation on higher ground for nesting.	**Potential.** 1975 observation in Lagoon.	**No suitable habitat in vegetation management areas. No effect.**
black rail *Laterallus jamaicensis coturniculus*	FSC, ST, CFP	Rarely seen resident of saline, brackish, and fresh emergent wetlands in the San Francisco Bay area. Nest in dense stands of pickleweed	**Present.** Observed at coves in Bolinas Lagoon at the mouth of Audubon Canyon, Pike County Gulch, as well as suitable marsh habitat in the vicinity of Pt. Reyes National Seashore.	**Resident in Lagoon brackish marsh. No suitable habitat on or adjacent to KI. No effect.**
western snowy plover *Charadrius alexandrinus nivosus*	FT, CSC	Found on sandy beaches, salt pond levees and shores of large alkali lakes. Need sandy gravelly or friable soils for nesting.	**Present.** Nests on Bolinas Lagoon spit, Point Reyes Beach, Drake's Beach spit, Limantour spit.	**Suitable habitat present on south island shore beach. No recent occurrence on KI. Project may improve habitat value of KI for nesting plovers.**
whimbrel *Numenius phaeopus*	FSC	Spring migrant at the Central California Coast. Forages on rocky intertidal, sandy beach marine habitats, and intertidal mudflats of estuarine habitats.	**Present**. Documented to occur by PRBO. Suitable foraging habitat available, may occur as spring migrant.	**Forages in Lagoon. No effect.**
long-billed curlew *Numenius americanus*	FSC, CSC	Winters in large coastal estuaries, upland herbaceous areas, and croplands. Breeds in northeastern California in wet meadow habitat.	**Present.** Observed foraging in tidal mudflats of Lagoon. Winter visitor.	**Forages in Lagoon. No effect.**

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marbled godwit *Limosa fedoa*	FSC	Migrant and winter visitor along California Coast. Most common on estuarine mudflats but also occurs on sandy beaches, open shores, saline emergent wetlands, and adjacent wet upland fields.	**Present.** Observed foraging in tidal mudflats of Lagoon. Winter visitor.	**Forages in Lagoon. No effect.**
red knot *Calidris canutus*	FSC	Fall and spring migrant in coastal estuarine habitats. Prefers estuarine sand or mud flats.	**High Potential.** May occur as spring or fall migrant to forage in mudflats of the Lagoon.	**Forages in Lagoon. No effect.**
California least tern *Sterna antillarum browni*	CSC	Nests along the coast from San Francisco Bay to Baja. Colonial breeder on sparsely vegetated flat substrates.	**Not Present.** No known nesting records of species in Lagoon	**May forage on Lagoon. No effect.**
black skimmer *Rynchops niger*	CSC	Nests on gravel bars, low islets, and sandy beaches in unvegetated sites.	**Moderate Potential**. No records of nesting colony at lagoon but may occur to forage as transient.	**May forage on Lagoon. No effect.**
Marbled murrelet *Brachyrampus marmoratus*	FT, SE	Breeds in old-growth redwood stand along coast.	**Not present.** No suitable habitat on Lagoon.	**No effect.**
tufted puffin *Fratercula cirrhata*	CSC	Uncommon species that nests on islands and coastal cliffs. Breeding colony on Farallon Islands.	**Low Potential.** May occur to forage in Lagoon, suitable nesting habitat not available.	**May forage on Lagoon. No effect.**

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western burrowing owl *Athene cunicularia hypugea*	FSC, CSC	Frequents open grasslands and shrublands with perches and burrows. Preys upon insects, small mammals, reptiles, birds, and carrion. Nests and roosts in old burrows of small mammals.	**Low Potential.** Uncommon species in region. May occur in grassland	**No records for Island nor suitable nesting habitat. No effect.**
northern spotted owl *Strix occidentalis caurina*	FT	Rely on large patches of old growth forest for hunting, roosting, nesting.	**Low Potential.** Breeding population located at nearby Bolinas Ridge. Not likely to utilize the Lagoon or adjacent area for roosting, nesting, or hunting.	**No suitable habitat on Island. No effect.**
Vaux's swift *Chaetura vauxi*	FSC, CSC	Forages high in the air over most terrain and habitats but prefers rivers/lakes. Requires large hollow trees for nesting.	**Present.** Documented nesting occurrence in chimney just north of Bolinas Lagoon.	**May forage over Island. No effect.**
black swift *Cypseloides niger*	FSC, CSC	Nests in riparian jungles of willow, often mixed with cottonwoods with thick lower story.	**Moderate Potential.** Suitable habitat available at Pine Gulch Creek. Documented to occur at Pt. Reyes National Seashore.	**May forage over Island. No effect.**
rufous hummingbird *Selasphorus rufus*	FSC	Found in a wide variety of habitats that provide nectar-producing flowers. A common migrant and uncommon summer resident of California.	**High Potential.** Suitable nesting and foraging habitat available in upland areas adjacent to lagoon.	**May forage on Island. No effect.**

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Allen's hummingbird *Selasphorus sasin*	FSC	Breeds in sparse and open woodlands, coastal redwoods, and sparse to dense scrub habitats. Distribution highly dependent on abundance of nectar sources.	**High Potential.** Suitable nesting and foraging habitat available in upland areas adjacent to lagoon.	**Could breed on Island.**
olive-sided flycatcher *Contopus cooperi*	FSC	Most often found in montane conifer forests where tall trees overlook canyons, meadows, lakes or other open terrain	**Present.** Observed singing in willow adjacent to lagoon during May 2004 assessment. Suitable breeding and foraging habitat available in upland riparian areas.	**May forage over Island. No effect.**
little willow flycatcher *Empidonax traillii brewsteri*	FSC, SE	Most numerous where extensive thickets of low, dense willows edge on wet meadows, ponds, or backwaters. Winter migrant.	**Low Potential.** May occur as winter migrant. Willow riparian habitat available adjacent to Lagoon.	**Very little suitable habitat on the Island; winter migrant only. No effect.**
purple martin *Progne subis*	CSC	Inhabits woodlands, low elevation coniferous forest. Nest in old woodpecker cavities and human-made structures.	**High Potential.** May occur as transient or nest in woodland habitat adjacent to the lagoon.	**May forage over Island. No effect.**
bank swallow *Riparia riparia*	FSC, ST	Migrant in riparian and other lowland habitats in western California. Nests in riparian areas with vertical cliffs and bands with fine-textured or sandy soils in which to nest.	**High Potential.** May occur as migrant to forage over lagoon and adjacent upland areas.	**May forage over Island. No effect.**

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California thrasher *Toxostoma redivivum*	FSC	Common resident of foothills and lowlands in cismontane California. Occupies moderate to dense chaparral habitats and extensive thickets in young or open valley foothill riparian habitat.	**High Potential.** Suitable chaparral habitat available in upland habitat adjacent to lagoon.	**No suitable habitat on Island. No effect.**
loggerhead shrike *Lanius ludovicianus*	FSC, CSC	Prefers open habitats with scattered shrubs, trees, or posts from which to forage for large insects. Nest well concealed above ground in densely-foliaged shrub or tree.	**Low Potential**. Typical open grassland habitat is not present.	**No suitable habitat on Island. No effect.**
yellow warbler *Dendroica petechia brewsteri*	CSC	Nests in riparian stands of willows, cottonwoods, aspens, sycamores, and alders. Also nests in montane shrubbery in open conifer forests.	**Low Potential.** Suitable breeding habitat available in riparian habitat adjacent to Lagoon. Relatively uncommon. Documented breeder at Olema Marsh.	**No suitable habitat on Island. No effect.**
hermit warbler *Dendroica occidentalis*	FSC	Frequents mature stands of conifers with open to dense canopy for breeding.	**Low Potential**. May rarely occur in transitional habitat during migration.	**No suitable habitat on Island. No effect.**

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saltmarsh common yellowthroat *Geothlypis trichas sinuosa*	FSC, CSC	Frequents low, dense vegetation near water including fresh to saline emergent wetlands. Brushy habitats used in migration.	**Present.** Commonly observed species in wetlands in the vicinity. May occupy salt marsh and riparian habitats .	**May forage on Island. No effect.**
tricolored blackbird *Agelaius tricolor*	FSC, CSC	Usually nests over or near freshwater in dense cattails, tules, or thickets of willow, blackberry, wild rose or other tall herbs.	**Low Potential**. Typical freshwater emergent vegetation is not present. Foraging habitat (grassland, pasture) is not present.	**No suitable habitat on Island. No effect.**
Reptiles and Amphibians				
western pond turtle *Clemmys marmorata*	FSC, CSC	Occurs in perennial ponds, lakes, rivers and streams with suitable basking habitat (mud banks, mats of floating vegetation, partially submerged logs) and submerged shelter.	**No Potential**. Excluded by marine salinity surrounding island and lack of fresh-brackish perennial water on island.	**No suitable habitat on Island. No effect.**

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California red-legged frog *Rana aurora draytonii*	FT, CSC	Associated with quiet perennial to intermittent ponds, stream pools and wetlands. Prefers shorelines with extensive vegetation. Documented to disperse through upland habitats after rains.	**Present.** Known to occur in Pt. Reyes National Seashore vicinity, including Pine Gulch Creek and freshwater areas around the Lagoon.	**No suitable habitat on Island. No effect.**
foothill yellow-legged frog *Rana boylii*	FSC, CSC	Found in or near rocky streams in a variety of habitats. Feed on both aquatic and terrestrial invertebrates.	**Moderate Potential**. Pine Gulch Creek may provide suitable habitat conditions; not associated with saline habitats.	**No suitable habitat on Island. No effect.**
loggerhead turtle *Caretta caretta*	FE	Circumglobal, occurring throughout the temperate and tropical regions. In the eastern Pacific, most records are of juveniles off the coast of California.	**Present** in offshore waters.	**No suitable habitat in the Lagoon. No effect.**
Green turtle *Chelonia mydas*	FE	In the eastern North Pacific, green turtles have been sighted from Baja California to southern Alaska, but most commonly occur from San Diego south.	**Present in offshore waters.**	**No suitable habitat in the Lagoon. No effect.**
Leatherback turtle *Dermochelys coriacea*	FE	Pelagic but also forage in coastal waters. The most migratory and wide ranging of sea turtle species.	**Present** in offshore waters. Offshore waters designated as critical habitat from Pt. Arena to Pt. Arguello.	**No suitable habitat in the Lagoon. No effect.**

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Fishes				
Pacific lamprey *Lampetra tridentata*	FSC	Anadromous fish found in the Sacramento-San Joaquin estuary and river system. Spawn in riffle areas with strong current in cool streams. Adults occur in bay and ocean waters.	**High Potential**. CDFG surveys during 1994-96 found lamprey ammocoetes in Pine Gulch Creek.	**Occurs in the Lagoon. Potential for impact from water intake.**
green sturgeon *Acipenser medirostris*	FSC, CSC	Anadromous fish that spawns in Sacramento river. Feeds in estuaries and bays, including San Francisco Bay.	**Low Potential**. May rarely occur in Bolinas Lagoon. Not encountered during CDFG surveys.	**Rare occurrence. Water intake poses no threat to this species.**
Delta smelt *Hypomesus transpacificus*	FE	Found only in the Sacramento and San Joaquin River estuary.	**Not present.**	**No effect.**
coho salmon-central CA coast ESU *Oncorhynchus kisutch*	FT, SE	Require beds of loose, silt-free, coarse gravel for spawning. Also need cover, cool water and sufficent oxygen.	**Present.** Anecdotal reports suggest that Pine Gulch Creek supported runs of this species. Not encountered during CDFG surveys 1994-96. Also occurs in Lagunitas Creek drainage, Redwood Creek Watershed.	**Spawns in Pine Gulch Creek and smolts therefore occur in the Lagoon.**
steelhead-central CA coast ESU *Oncorhynchus mykiss*	FT	From Russian River south to Soquel Creek and Pajaro River. Also San Francisco and San Pablo Bay Basins.	**Present**. Documented to occur in Pine Gulch Creek during CDFG surveys 1994-96.	**Spawns in Pine Gulch Creek and possibly in Easkoot Creek. Smolts therefore occur in the Lagoon.**

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Steelhead—central valley ESU *Oncorhynchus mykiss*	FT	This population occurs in the Central Valley of California (Sacramento and San Joaquin Rivers and their tributaries)	**Not present.**	**No effect.**
California coastal chinook salmon *Oncorhynchus tshawytscha*	FT, SE, NMFS	Spawn in coastal streams at temps. from 4-14C. Prefer beds of loose, silt-free, coarse gravel and cover nearby for adults.	**Low Potential**. Not documented to occur in Pine Gulch Creek.	**Not present. No effect**
Tomales roach *Lavinia symmetricus ssp. 2*	CSC	Found in small, warm intermittent streams in the Tomales Bay watershed. Habitat generalists.	**Not Present**. Known from tributaries to Tomales Bay. Roach documented in Pine Gulch Creek are likely the Sacramento-San Joaquin subspecies.	**Not present. No effect**
tidewater goby *Eucyclogovius newberryi*	FE, CSC	Found in the brackish waters of coastal lagoons, marshes, creeks, and estuaries. Unique among fishes of the Pacific coast, gobies are restricted to waters of low salinity in coastal wetlands..	**Low Potential**. Suitable habitat available in Bolinas Lagoon though no known occurrences despite biological survey efforts.	**Not present. No effect**
Invertebrates				
Black abalone *Haliotis cracherodii*	FE	Range from about Point Arena to Baja but are rare north of San Francisco. Typically found in crevices, cracks, and holes of intertidal and shallow subtidal rocks in areas of moderate to high surf.	**Areas along coast are designated critical habitat.**	**No suitable habitat in Lagoon. No effect.**

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White abalone *Haliotis sorenseni*	FE	Found in open low and high relief rock or boulder habitat that is interspersed with sand channels from the Channel Islands south.	**Not present**	**No effect.**
mimic tryonia (California brackish-water snail) *Tryonia imitator*	none	Inhabits coastal lagoons, estuaries and salt marshes from Sonoma Co. south to San Diego Co. Able to withstand a wide range of salinities.	**Moderate Potential.** Suitable habitat available in Bolinas Lagoon though no records exist of occurrence.	**May occur in the Lagoon. No effect.**
California freshwater shrimp *Syncaris pacifica*	FE, SE	Endemic to Marin, Napa, and Sonoma Cos. Found in shallow pools away from streamflow in low gradient streams where riparian cover is moderate to heavy.	**Low Potential.** Uncommon species though observed at Lagunitas Creek and Olema Creek.	**No habitat on the Island. No effect.**
Tomales isopod *Caecidotea tomalensis*		Inhabits localized fresh-water ponds or streams with still or near-still water.	**High Potential**. 1984 observation in Audubon Canyon Ranch (Volunteer Canyon) tributary to Bolinas Lagoon.	**No habitat on the Island. No effect.**
Ricksecker's water scavenger beetle *Hydrochara rickseckeri*	FSC	Aquatic, known from the San Francisco Bay area.	**High Potential**. 1940 record from the vicinity of Bolinas.	**May occur in the Lagoon. No effect.**

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bumblebee scarab beetle *Lichnanthe ursina*	FSC	Inhabits coastal sand dunes from Sonoma Co. south to San Mateo Co. . Usually flies close to sand surface near the crest of dunes.	**Low Potential**. Observed along shoreline near Inverness, 1980; however, dune habitat is limited in Bolinas Lagoon.	**Project could provide improved habitat conditions for this species.**
sandy beach tiger beetle *Cicindela hirticollis gravida*	FSC	Occurs along non-brackish areas of coast.	**Moderate Potential**. Suitable habitat on south shore beach and high sand flats.	**Project could provide improved habitat conditions for this species**
Myrtle's silverspot butterfly *Speyeria zerene myrtleae*	FE	Restricted to the foggy coastal dunes/hills of the Point Reyes peninsula. Larval foodplant thought to be *Viola adunca.*	**Low Potential**. Larval host plant is not likely present in Bolinas Lagoon area. Observed as recently as 2003 in the vicinity of North Beach and Drake's Estero.	**No habitat on the Island. No effect.**
Point Reyes blue butterfly *Icaricia icarioides parapheres*	FSC	Confined to the Pt. Reyes Peninsula. Occurs in stable sand dunes with *Lupinus arboreus and L. varicolor.*	**Low Potential**. 1974 record from Point Reyes Dunes. Suitable habitat limited in Bolinas Lagoon.	**No habitat on the Island. No effect.**

Appendix D. Special status wildlife species that may occur in the vicinity of Bolinas Lagoon. Shaded rows indicate that may occur on Kent Island (KI) or in adjacent habitat that could be impacted by the Project. List compiled from USFWS Species Lists (USFWS 2012) and CNDDB (CDFG 2012) for the USGS Bolinas Quadrangle. Modified and updated from Table A-5 in the *Bolinas Lagoon Ecosystem Restoration Feasibility Study* (2006).

monarch butterfly *Danaus plexippus*	none	Winter roost sites located in wind-protected tree groves with nectar and water sources nearby.	**Low Potential**. Roost trees are not likely present in Bolinas Lagoon. Documented to roost throughout Bolinas, Pt. Reyes National Seashore, Tennessee Valley, Muir Beach, Fort Barry Military Reservation.	**Not observed to roost in Pines or Cypress on KI. No effect.**

*** Key to status codes:**
Status codes used above are:
FE - Federal Endangered
FT - Federal Threatened
FC - Federal Candidate
FPD - Federal Proposed Delisted
FSC - United States Fish and Wildlife Service Federal Species of Concern
NMFS - Species under the Jurisdiction of the National Marine Fisheries Service
SE - State Endangered
CSC - CDFG Species of Special Concern, CSC (Draft) - 4 April 2001 Draft
CDFG Species of Special Concern
CFP - California Fully Protected Species
SLC - Species of Local Concern
None - No status given but rookery sites are monitored by CDFG
List 1B - CNPS 1B List, Endangered, Threatened, or Rare in California
List 2- CNPS List 2 Plants are rare, threatened, or endangered in California, but more common elsewhere