Appendix 5
Vegetation Management of Tidal Marsh Edges, San Francisco Estuary

Working examples of vegetation management strategies for tidal marsh – terrestrial edges

5.1. Sonoma Baylands, Sonoma County.

Shoreline type: artificial levee, bay mud sediments, slope near 5:1
Local dominant vegetation: wild radish (*Raphanus sativa;* **5.1a**); creeping wildrye gradually displacing radish (*Leymus triticoides*, **5.1b, 5.1c**) and contacting narrow high tide line stands of zoned gumplant, pickleweed (*Grindelia stricta, Sarcocornia pacifica,* **5.1d**)
Major habitat restoration objectives: endangered wildlife habitat, recovery (California clapper rail, salt marsh harvest mouse; complex channelized tidal salt marsh with high tide refuge)
Appropriate local terrestrial-tidal marsh ecotone model for objectives: Petaluma Marsh and China Camp


5.1a


5.1b


5.1c


5.1d

Recommended management options:

5.1.1. *Advance propagation of local native planting stock*. Collect and store seed of native meadow barley from local stands at Sears Point (existing Sonoma Baylands levee populations are non-local introductions) one year in advance of stewardship activities. Harvest seed in summer. Collect and propagate (nursery or garden cultivation) creeping wildrye from native Sears Point populations (note: existing Sonoma Baylands levee populations are non-local introductions). Propagate/harvest vegetative divisions of creeping wildrye in late fall, and transplant during following winter-spring-summer period.

5.1.2. *Assess wildlife use and weeds source populations*. In consultation with tidal marsh wildlife experts, assess use of the site in existing conditions by wildlife. Integrate practical measures (adjust time of day, tide, season of work, sensitive locations, within vegetation management requirements) to minimize weeding and planting impacts to wildlife. Identify local indicators of normal spring high tide line and extreme high water lines (drift-lines, erosion). Assess potential weed sources that may invade weed-cleared, treated plots with disturbed, open soil. Identify stands of potential seed sources (such as star-thistle, perennial pepperweed, stinkwort) that may disperse to treatment plots. Mow or cut these during flowering to prevent buildup of weed seed sources near treatment plots, if feasible. Consider potential dispersal by trucks, fabric, boots of volunteers.

5.1.3. *Select large consolidated blocks of radish to treat*. Based on availability of labor, and site-specific restrictions, select appropriate size plots for weed removal. High potential feasibility techniques for this location and scale include salinization, repeat mowing, or herbicide application. Moderate feasibility techniques include solarization. Low feasibility techniques include manual removal. Selection criteria for treatment sites should focus on radish stands adjacent to high-quality tidal marsh habitat, or high-quality native terrestrial ecotone vegetation stands. Plots should extend from salt marsh (gumplant/pickleweed) to opposite landward crest of levee, to minimize seed rain from weeds along levee roadsides.

5.1.4. *Initiate preliminary trials (pilot projects) of high-feasibility weed reduction methods*. Because the site has road access throughout, and vegetation is relatively uniform, large replicated blocks can be established for preliminary tests of different methods. Mowing/raking in early flowering stages would be the most feasible and cost-effective test. Solarization/black plastic patches, salinization, would be suitable for large-scale tests. Mowing, solarization/black plastic treatments would probably need to be repeated from April to June. Re-inspect treated sites and manually remove survivors that produce seed, or re-mow treated plots.

5.1.5. *Initiate re-treatment or revegetation in preliminary test plots*. If seed regeneration of radish is significant, re-treat the initial plots, or apply the most effective and efficient treatment identified by preliminary tests. Begin revegetation of radish-cleared plots with propagated or stockpiled local meadow barley, creeping wildrye, in fall after successful treatments.

5.1.6. *Reiterate and modify*. Expand treatment plots, with priority to adjacent areas. Repeat refined removal, transplanting methods. Diversify revegetation of treated plots with meadow sedge in planted colonies 5 to 20 m long, 2 to 3 m wide near the high tide line; further

diversify plantings with basket sedge, meadow sedge, wire rush, marsh baccharis, western ragweed, western goldenrod, (local) common/Suisun aster, (local) bee-plant, (local) yarrow, blue elder. Plant coast live oak at wide intervals on the upper slope of the levee, near the crest. Plant patches of spikeweed in rows along the levee roadside, up to the edge of tire tracks/trampled areas. Plant infrequent patches of toyon, coyote brush, at irregular positions on the levee slope.

5.2. Corte Madera Ecological Reserve, Marin County (Muzzi Marsh) west central

Shoreline type: artificial levee, bay mud sediments, slope gentler than 5:1
Local dominant vegetation: ryegrass (*Lolium multiflorum*), in nearly pure stands (**5.2a**) or with patches of expanding Harding grass (*Phalaris aquatica* **5.2b**), above pickleweed salt marsh plain with cordgrass-bordered channels, expanding alkali-bulrush colonies. (Occupied clapper rail habitat)
Appropriate local terrestrial-tidal marsh model for objectives: alluvial grassland, riparian woodland and scrub. **Reference sites**: China Camp stream valleys.
Major habitat restoration objectives: endangered wildlife habitat, recovery (California clapper rail, salt marsh harvest mouse; complex channelized tidal salt marsh with high tide refuge)


Recommended management options:
5.2.1. *Advance propagation of local native planting stock*. Collect and propagate local meadow sedge and additional clones from China Camp. Collect and propagate local native wire rush and creeping wildrye from China Camp tidal marsh edges. Propagate/harvest in late fall, propagate and cultivate the following winter-spring-summer period. Collect and propagate toyon berries coast live oak acorns from local San Rafael hillslopes.

5.2.2. *Assess wildlife use and weeds source populations*. In consultation with tidal marsh wildlife experts, assess use of the site in existing conditions by wildlife and follow recommended impact avoidance measures (see 5.1.2). Identify local indicators of normal spring high tide line and extreme high water line. Assess potential weed sources that may invade weed-cleared, treated plots with disturbed, open soil. Identify stands of potential seed sources (such as fennel, jubata grass, acacia, Australian bentgrass, stinkwort) that may disperse to treatment plots. Mow or cut these during flowering to prevent buildup of weed seed sources

near treatment plots, if feasible. Consider potential dispersal by trucks, fabric, or boots of volunteers. Avoid mechanized mowing equipment during clapper rail nesting season. Avoid working at high tides when clapper rails require undisturbed high tide cover.

5.2.3. *Select large consolidated blocks of ryegrass to treat.* Based on available labor, select appropriate size plots for weed removal. Selection criteria should focus on radish stands away from current year nest locations of clapper rails. Plots should extend from salt marsh (gumplant/pickleweed) to opposite landward crest of levee, to minimize seed rain from weeds dispersing along levee foot trails.

5.1.4. *Initiate preliminary trials (pilot projects) of high-feasibility weed reduction methods.* Several large replicated blocks should be assigned to each selected treatment method for preliminary tests. Repeated mowing (close to ground level)/raking in early flowering stages would be one non-lethal pre-treatment technique to test in combination with lethal treatments. The most feasible and cost-effective potentially lethal treatments here would be solarization/black plastic patches. Salinization may not be practical or appropriate in this setting because pumping salt water from sloughs would require disturbance and entry of sensitive salt marsh and channel bank habitat. Broadcast herbicide (glyphosate) application at this (ecological reserve) location may be excessively controversial. Mowing, solarization/black plastic treatments would probably need to be repeated from March to June. Re-inspect treated sites and manually remove survivors that vegetatively regenerate, or re-apply plastic covers.

5.2.5. *Initiate revegetation in preliminary test plots.* If vegetative regeneration of ryegrass is significant after fall rains begin, repeat follow-up treatments (manual removal) or black plastic treatment. When regeneration is sufficiently minimized (<50% cover live ryegrass; predominantly thatch) begin revegetation of ryegrass-cleared plots with propagated local meadow sedge, meadow barley, creeping wildrye, and wire rush the following winter-spring. Plant wire rush and meadow barley along the high tide line, in segments 1 meter wide and approximately 4 meters long. Plant discontinuous linear patches of gumplant 1 meter wide and approximately 2 to 4 meters long along the high tide line at irregular intervals, with gaps 4 to 10 meters apart. Locate gumplant colonies near small branch channels of adjacent sloughs, near known clapper rail nests or home ranges, or near patches of distinct tall vegetation in the marsh plain.

5.2.6. *Reiterate and modify.* Expand treatment plots, with priority to adjacent areas. Repeat refined removal, transplanting methods. Diversify revegetation of treated plots with coast live oak at wide intervals on the upper slope of the levee, near the crest. Plant patches of spikeweed in rows along the levee roadside, up to the edge of tire tracks/trampled areas. Plant infrequent small patches of toyon, coyote brush, at irregular positions on the levee slope. Locate coyote brush patches near known clapper rail nests or home ranges, or near patches of distinct tall vegetation in the marsh plain.

5.3. Corte Madera Ecological Reserve, Marin County (Muzzi Marsh) south

Shoreline type: artificial levee, bay mud sediments, slope steeper than 3:1, low crest elevations, narrow slope.
Local dominant vegetation: fennel (*Foeniculum vulgare*), subdominant Harding grass (*Phalaris aquatica*), frequent radish (*Raphanus sativa*) and patches of non-native annual grasses.
Appropriate local terrestrial-tidal marsh model for objectives: hillslope grassland, and scrub.
Reference sites: China Camp hillslope.
Major habitat restoration objectives: endangered wildlife habitat, recovery (California clapper rail, salt marsh harvest mouse; complex channelized tidal salt marsh with high tide refuge)

Recommended management options:

5.3.1. *Advance propagation of local native planting stock*. See 5.2.1.

5.3.2. *Assess wildlife use and weeds source populations*. See 5.2.2. Focus on locations of perennial pepperweed, Australian bentgrass, stinkwort. Prevent seed production in these source populations or eliminate them in advance of weed removal in treatment plots. Avoid mechanized mowing equipment during clapper rail nesting season. Avoid working at high tides when clapper rails require undisturbed high tide cover.

5.3.3. *Select accessible consolidated blocks of fennel-Harding grass vegetation, and selected perennial pepperweed patches to treat*. Based on levee access by foot, distance from truck access on the main levee, and available labor, select appropriate size plots for weed removal. Selection criteria should focus on fennel-Harding grass stands away from current year nest locations of clapper rails. Plots should extend from salt marsh (gumplant/pickleweed) to opposite landward crest of levee, to minimize seed rain from weeds dispersing along levee foot trails.

5.3.4. *Initiate preliminary trials (pilot projects) of high-feasibility weed reduction methods*. Several large replicated blocks should be assigned to each selected treatment method for preliminary tests. Disperse treatment plots so that no continuous large, barren segments of levee are created in

or adjacent to clapper rail home ranges. Begin cutting fennel, Harding grass, pepperweed in spring to prevent flowering. The most feasible and cost-effective potentially lethal treatments here would be (a) manual removal by digging, and (b) solarization/black plastic patches following cutting. Salinization may not be practical or appropriate in this setting because pumping salt water from sloughs would require disturbance and entry of sensitive salt marsh and channel bank habitat at high tide. Broadcast herbicide (glyphosate) application at this (ecological reserve) location may be excessively controversial. Solarization/black plastic treatments would probably need to be repeated from March to June. Re-inspect treated sites and manually remove survivors that vegetatively regenerate, or re-apply plastic covers.

5.3.5. *Initiate revegetation in preliminary test plots*. Seedling recruitment of both fennel and Harding grass are likely for the year following initial removal treatments. If vegetative regeneration of Harding grass is significant after fall rains begin, repeat follow-up treatments (manual removal) or black plastic treatment. Control fennel seedlings with a hoe. Prepare to re-apply black plastic treatments if annual grasses reinvade cleared treatment plots. When regeneration is sufficiently reduced (cover is predominantly thatch) begin revegetation of ryegrass-cleared plots with propagated gumplant, creeping wildrye, coyote-brush, toyon, on this narrower, steeper levee. Diversify plantings with basket sedge, meadow sedge, marsh baccharis, western ragweed, western goldenrod, and common aster. Generally follow planting patterns for the wider levee recommended at 5.2.5. Use meadow barley (seeding) to fill gaps between transplants, or use less noxious ryegrass to resist invasion by more noxious ripgut brome, Australian bentgrass, Harding grass, and fennel.

5.3.6. *Reiterate and modify*. Expand treatment plots, with priority to adjacent areas. Repeat refined removal, transplanting methods.

5.4. Triangle Marsh, Corte Madera, Marin County

Shoreline type: artificial levee, compacted terrestrial fill, slope near 5:1
Dominant vegetation: immature, irregular pioneer weed assemblage, mostly bird's-foot trefoil, annual grasses, Harding grass above early succession intertidal bench/salt marsh restoration area. Revegetation has been initiated with creeping wildrye, gumplant; scrub species present mostly on landward slope and upper seaward slope.
Appropriate local terrestrial-tidal marsh model for objectives: hillslope grassland, and scrub.
Reference sites: Ring Mountain (adjacent); China Camp, shoreline hillslope.
Major habitat restoration objectives: endangered wildlife habitat, recovery (California clapper rail, salt marsh harvest mouse; tidal salt marsh with high tide refuge)


Recommended management options:

5.4.1. *Advance propagation of local native planting stock*. See 5.2.1., with emphasis here on coastal scrub species, gumplant, and creeping wildrye. Diversify plantings with basket sedge, meadow sedge, marsh baccharis, western ragweed, western goldenrod, and common aster. In addition, propagate local willow populations from hillslope seeps, surface streams.

5.4.2. *Assess wildlife use and weed source populations*. See 5.2.2. Focus on locations of French broom, teasel, acacia, Harding grass, and annual grasses. Prevent or minimize seed production in these source populations (by cutting during flowering) or eliminate them in advance of weed removal in treatment plots. Avoid mechanized mowing equipment during clapper rail nesting season. Avoid working at high tides when clapper rails require undisturbed high tide cover.

5.4.3. *Select small treatment blocks of mixed weeds/native revegetation areas.* All levee area is accessible from the adjacent road. Weeds occur mixed with ongoing native revegetation, which requires small plot sizes or large plots with much precise manual work to avoid damage to established plantings.

5.4.4. *Initiate preliminary trials (pilot projects) of high-feasibility weed reduction methods*. Several small replicated blocks should be assigned to each selected treatment method for preliminary tests. Begin cutting Harding grass, annual grasses in spring to prevent flowering and seed set. Cut bird'sfoot trefoil taproots below ground level with a tile spade. Manually pull French broom seedlings. The most feasible and cost-effective potentially lethal treatments here would be (a) manual removal by pulling or digging, and (b) small-scale solarization/black plastic patches following cutting. Spot application of herbicide (glyphosate) application at this (ecological reserve) location may be excessively controversial. Solarization/black plastic treatments would probably need to be repeated from March to June. Re-inspect treated sites and manually remove survivors that vegetatively regenerate, or re-apply plastic covers.

5.4.5. *Initiate revegetation in preliminary test plots*. Seedling recruitment of Harding grass is likely for the year following initial removal treatments. If vegetative regeneration of Harding grass is significant after fall rains begin, repeat follow-up treatments (manual removal). Prepare to re-apply black plastic treatments if annual grasses reinvade cleared treatment plots. When regeneration of noxious weeds is sufficiently minimized (cover is predominantly thatch)

begin revegetation of ryegrass-cleared plots with propagated gumplant, creeping wildrye, coyote-brush, and meadow barley. Generally follow planting patterns for the wider levee recommended at 5.3.5.

5.4.6. *Reiterate and modify*. Expand treatment plots, with priority to adjacent areas. Repeat refined removal, transplanting methods. Terrestrial soil edge of tidal marsh may be amenable to reintroduction of regionally uncommon to rare plants.

5.5. Cogswell Marsh, Hayward

Shoreline type: artificial levee, bay mud sediments, slope steeper than 5:1
Local dominant vegetation: black mustard, non-native annual grasses, alkali-heath, pickleweed; gumplant is scarce or absent.
Appropriate local terrestrial-tidal marsh model for objectives: hillslope and lowland grassland.
Reference sites: Coyote Hills, Upper Newark Slough.
Major habitat restoration objectives: endangered wildlife habitat, recovery (California clapper rail, salt marsh harvest mouse; tidal salt marsh with high tide refuge)


Recommended management options:
See 5.1, Sonoma Baylands. Modifications include:
(a) Nearest native plant population borrow source for terrestrial species is Coyote Hills; nearest tidal marsh borrow source is adjacent Hayward tidal marsh.
(b) Herbicides are currently used for hybrid cordgrass control, and may be feasible for extensive stands of nonnative mustard; manual methods would apply to patchy pickleweed-alkali-heath mixed with weeds.
(c) Clapper rail precautions of 5.3 and 5.4 apply here, regarding plot size and distribution, timing, mechanical mowing;
(d) Primary revegetation species would include creeping wildrye, western ragweed, gumplant, marsh baccharis. Diversify plantings with basket sedge, marsh baccharis, western ragweed, western goldenrod, common aster, tarweeds, spikeweeds, blue elder.