Adaptive Integrated Vegetation Management of Invasive *Spartina densiflora* in the San Francisco Estuary

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*Spartina densiflora* (Chilean cordgrass) was introduced to Creekside Park along Corte Madera Creek, Marin County in the 1970’s as part of a restoration effort. It had been misidentified as a form of native *Spartina foliosa* (Pacific cordgrass) and was subsequently imported from Humboldt Bay where it now infests more than 2000 acres after dry ballast was deposited there during the timber trade with South America in the 19th Century. By 2004, *S. densiflora* dominated the marsh at Creekside Park and had spread to 12 other marshes in Marin as well as Point Pinole and Mare Island across the North Bay. The Invasive Spartina Project and Friends of Corte Madera Creek Watershed began treatment on these infestations in 2004-2006, relying predominantly on imazapyr application in the initial years to gain control of the problem while also digging isolated plants and outoters with the Conservation Corps. Until receiving an amendment to the Biological Opinion in 2008, entry into many infested marshes was restricted until the end of endangered California clapper rail breeding season on September 1. Since *S. densiflora* sets seed by early July, that initial timing made it impossible to stay ahead of the infestation. In addition, imazapyr produced extremely variable results, especially on established meadow areas and on small plants with less leaf surface area. Mowing the persistent dead biomass remaining at meadows of previously-sprayed *S. densiflora* allowed for fresh green growth that could identify targets for retreatment with imazapyr or digging. Despite these considerable challenges, the annual imazapyr treatment significantly reduced the infestation, allowing the IVM strategy to shift by 2010 to purely manual removal by ISP biologists at 95% of the sites.

Constraints on *Spartina densiflora* Control in the San Francisco Estuary

- Established stands of *S. densiflora* one year post-treatment can display this yellow/green/gray, half-dead appearance
- Not healthy enough to translocate another herbicide application in this state
- Managed with mowing to illicit new green growth amenable to herbicide and/or to ease manual removal
- One imazapyr treatment does suppress seed production for 2 years, a valuable tool, and kills a portion of the plants
- Imazapyr is also less effective on small plants and seedlings (presumably insufficient leaf surface area)
- Limited amount of herbicide required due to reduction in above-ground biomass
- A herbicide is effective, the marsh plain does not need to be destroyed by digging all at once

Mowing of previously herbicide-treated *Spartina densiflora* in mid-elevation marsh

- Removes dead (or nearly dead) above-ground biomass allowing for best assessments of current plant status and development of an adaptive IPM (Integrated Pest Management) treatment strategy
- Weakens the reserves of the plants by interrupting the transfer of nutrients back down to ground
- No cutting usually to preserve refuges for seed from the standing dead marsh

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- Unfed Biological Opinion amended in 2008, ISP was allowed to treat to known California clapper rail breeding sites before Sept 1 (refer to inventory sites on the map below on the ground)
- Full comprehensive treatment of all 168 Spartina sites around the Estuary was AN IMPOSSIBLE TASK for the first 3 years
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