

# ISP Target Species Descriptions

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There are one native and four non-native species of cordgrass in the San Francisco Estuary. Key aspects of the cordgrass species found in the Estuary are contrasted below. All species and hybrids are perennial, salt-tolerant grasses, and most spread both sexually and asexually<sup>1</sup>. The roles these species play in their native habitats give ecologists an indication of their potential to alter the salt marsh ecosystem of San Francisco Bay.

## NATIVE: PACIFIC CORDGRASS (*SPARTINA FOLIOSA*)

California's only native cordgrass, *S. foliosa*, grows in a narrow range of the tidal spectrum due to its relatively short stature and intolerance for drought. *Spartina foliosa* is a vital component of the salt marsh plant community, occurring at the lowest intertidal elevation of any native macrophyte. This lower tidal marsh zone occurs at the upper elevation of the mudflat and along channel banks and benches. Native cordgrass is also found scattered throughout the next zone in the elevational gradient, the middle tidal marsh zone, or pickleweed (*Salicornia virginica*) marsh plain. *Spartina foliosa*'s slender leafy shoots seldom exceed five feet in height including seed heads, with most shoots ranging from approximately one to three feet tall. Cordgrass height correlates with its tolerance of submersion, and as such *S. foliosa* can occupy only a limited range in the lower and middle tidal marsh zones (Cain and Harvey 1983). Its leaves and stems wither in fall and are shed in winter, as the clones die back to the mud substrate.



*Spartina foliosa* is particularly valued as habitat for the endangered California Ridgway's rail (*Rallus obsoletus obsoletus*), which spends most of its time foraging for food within, or close to, the protective canopy of cordgrass. California Ridgway's rails can move within *S. foliosa* stands, and they spend most of their time under cover of the cordgrass foliar canopy, usually selecting prey items such as benthic and aquatic invertebrates inhabiting the cordgrass stands and their edges. The benthic invertebrate community found in the substrate at the base of *S. foliosa* is also an important food source to a variety of other consumers including both resident and migratory shorebirds.

While it was widely recognized that hybrid *S. alterniflora* (discussed next) could potentially threaten the existence of native *S. foliosa*, control of the hybrids began sufficiently early that *S. foliosa* still anchors thousands of acres of tidal marsh throughout the Estuary. Most of the North Bay was relatively unimpacted by hybrid *S. alterniflora*, and more than 99% of the cordgrass in the remnant marshes throughout the Estuary is still intact *S. foliosa*. However, *S. foliosa* was assimilated into the hybrid swarm, and even locally extirpated, in some of the largest infestations around South San Francisco Bay, including the Alameda Flood Control Channel (Site 1) and Eden Landing (Site 13). These sites were the

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<sup>1</sup> Although academic researchers speculated early on that that hybrid *S. foliosa* × *densiflora* might reproduce sexually like hybrid *S. foliosa* × *alterniflora* was known to do, biologists working on the ISP have seen no evidence of this occurring.

focus of an extensive reintroduction effort by the Conservancy that began in 2010, establishing stands of *S. foliosa* that disperse seeds throughout these sites, leveraging the investment in direct planting.

### ATLANTIC SMOOTH CORDGRASS (*SPARTINA ALTERNIFLORA*) AND ITS HYBRIDS

Atlantic smooth cordgrass is unique among the world's cordgrass species in terms of its growth potential and ecological breadth. *Spartina alterniflora* is genetically similar to *S. foliosa*, but the two species have significant differences. In size, growth rate, pollen and seed production, culm (stem) density and ecological tolerances, *S. alterniflora* is more robust than *S. foliosa* (Smart and Barko 1978; Boyer, Callaway et al. 2000). The San Francisco Estuary population of *S. alterniflora* was introduced from seed collected in Maryland in the early-1970s to aid in a dredge spoils stabilization and marsh restoration experiment (Faber 2000). Genetic similarity to *S. foliosa* allowed multiple hybridization and eventual backcrossing events that produced the “hybrid swarm” that has posed the most widespread and intrusive threat to the Estuary (Daehler and Strong 1997). Pollen production, higher fertility, greater tolerance for both inundation and drought, and increased timeframe for flowering make these hybrids a prominent threat to native cordgrass by out-competition, pollen swamping, and hybrid assimilation (Rhymer and Simberloff 1996; Ayres, Garcia-Rossi et al. 1999; Anttila, King et al. 2000; Levin, Neira et al. 2006). Levin et al. (2006) reported that when stands of *S. foliosa* are displaced by hybrid *S. alterniflora*, the biomass of the benthic invertebrates declines by more than 70%, and the benthic community shifts from surface feeders to belowground feeders that are inaccessible to foraging birds.



Hybrid *S. alterniflora* was well established and widely distributed in the Central and South Bay at the start of the ISP Control Program, and the population peaked at 805 net acres<sup>2</sup> in 2005, just prior to initiation of the bay-wide treatment program. Between 2005 and 2022, the population was reduced by greater than 97% bay-wide, down to 20.7 net acres.

### CHILEAN CORDGRASS (*SPARTINA DENSIFLORA*) AND ITS HYBRID WITH PACIFIC CORDGRASS (*S. FOLIOSA*)

Chilean cordgrass (also called dense-flowered cordgrass) is a distinctive cordgrass species native to South America that grows as a bunchgrass in the middle marsh plain, eventually forming tussocks and meadows (Spicher and Josselyn 1985; Kittelson and Boyd 1997). *Spartina densiflora* was introduced to California in Humboldt Bay by dry ship ballast containing propagules from South American ports that traded lumber (Spicher and Josselyn 1985). Thought for most of the 20<sup>th</sup> century to be a form of Pacific

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<sup>2</sup> The ISP uses the term “net area” to define the extent of non-native *Spartina*. *Net area* refers to the size of the infestation if the space between stems were subtracted from the overall footprint of the plant or clump of plants. Net area is the metric typically used in botanical surveys.

cordgrass, *S. densiflora* was deliberately transplanted to a salt marsh restoration project at Creekside Park (4g) along Corte Madera Creek in Marin County in the 1970s. Within the salt marshes fringing Corte Madera Creek, it became a locally dominant component of the middle and high salt marsh vegetation, displacing even robust pickleweed.

Rapid and coordinated work by the ISP contained the bulk of the *S. densiflora* invasion within the Corte Madera Creek watershed, although populations were detected (and eliminated) in other areas of the bay, including Redwood City and Burlingame (San Mateo County), Point Pinole Regional Shoreline (Contra Costa County), the San Pablo Bay National Wildlife Refuge (Sonoma and Solano counties), and Tomales Bay (outer coast of Marin County). When established in close proximity to *S. foliosa*, *S. densiflora* has produced infertile hybrids with the native cordgrass that spread solely via vegetative growth (Ayres, Zaremba et al. 2008).



*Spartina densiflora* and hybrid *S. densiflora* x *foliosa* have been nearly eradicated from the Estuary and outer shore marshes following persistent implementation of an adaptive Integrated Vegetation Management (IVM) strategy that includes multiple treatment methods, including twice annual digging, or herbicide application and covering with black plastic. Because of the unique biology of this form of *Spartina*, including its dense, in rolled bunch-styled leaves (that reduces the plants ability to absorb herbicide treatment), and longer (3-5 year) seed viability, single-tooled approaches proved to be ineffective. Since 2020 virtually all detected *S. densiflora* plants were found and removed prior to their setting seed, which has led to greatly reduced infestation pressure while the seedbank has steadily depleted.

### ENGLISH CORDGRASS (*SPARTINA ANGLICA*)

English cordgrass is an aggressive invader of mudflats and salt marshes in Britain, New Zealand, Australia, and the Pacific Northwest. It originated in Britain as a fertile hybrid derived from introduced Atlantic smooth cordgrass and common cordgrass (*S. maritima*). It was introduced to the San Francisco Estuary at Creekside Park (4g) along Corte Madera Creek in Marin County, along with Chilean cordgrass (*S. densiflora*), in 1976. Unlike Atlantic smooth cordgrass and Chilean cordgrass, this species failed to disperse from its point of introduction to expand the infestation beyond Corte Madera Creek. It may be at or near its southern climatic limit on the Pacific Coast in the Estuary.

*Spartina anglica* is nearly eradicated from San Francisco Bay, and it is not known to occur in any other location in California. The ISP mapped just 0.03 m<sup>2</sup> of *S. anglica* in 2022.





## SALT-MEADOW CORDGRASS (*SPARTINA PATENS*)

In its native range on the Atlantic coast, salt-meadow cordgrass is naturally restricted to the well-drained high salt marsh and relatively moist sandy depressions at or above tidal influence. However, in the San Francisco Estuary, it has thrived along channel banks and on the pickleweed plain. *Spartina patens* arrived in the Estuary by the early 1960s in Southampton Marsh (Site 11; Benicia State Recreation Area), as evidenced by a sample present in the California Academy of Science's collection from circa 1962. At the initiation of treatment by ISP and the California Department of Parks and Recreation (State Parks) in 2005, 0.65 net acre of salt-meadow cordgrass was present in large, discrete patches at Southampton Marsh.



Monitoring and treatment of *S. patens* at Southampton Marsh is complicated by the presence of special status species, including a population of an endangered hemi-parasitic plant, soft bird's-beak (*Chloropyron molle* ssp. *Molle*), that can be adversely affected if its host plant, in this case *S. patens*, is killed. Also present are endangered California Ridgway's rails (intermittently) and State-listed California black rails.

ISP biologists assisted State Parks with monitoring and treatment during several years, and in 2016 a net cover of 35 m<sup>2</sup> was mapped. In 2020, State Parks assumed responsibility for the site, and ISP is not currently assisting with work on this species.

## REFERENCES

- Anttila, C. K., R. A. King, et al. (2000). "Reciprocal hybrid formation of *Spartina* in San Francisco Bay." *Molecular Ecology* **9**(6): 765-770.
- Ayres, D. R., D. Garcia-Rossi, et al. (1999). "Extent and degree of hybridization between exotic (*Spartina alterniflora*) and native (*S. foliosa*) cordgrass (Poaceae) in California, USA determined by random amplified polymorphic DNA (RAPDs)." *Molecular Ecology* **8**(7): 1179-1186.
- Ayres, D. R., K. Zaremba, et al. (2008). "Sexual reproduction of cordgrass hybrids (*Spartina foliosa* x *alterniflora*) invading tidal marshes in San Francisco Bay." *Diversity and Distributions* **14**(2): 187-195.
- Boyer, K. E., J. C. Callaway, et al. (2000). "Evaluating the progress of restored cordgrass (*Spartina foliosa*) marshes: belowground biomass and tissue nitrogen." *Estuaries* **23**: 711-721.
- Cain, D. and H. Harvey (1983). "Evidence of salinity-induced ecophenic variation in cordgrass (*Spartina foliosa* Trin.)." *Madrono* **30**(1): 50-62.
- Daehler, C. C. and D. R. Strong (1997). "Hybridization between introduced smooth cordgrass (*Spartina alterniflora*; Poaceae) and native California cordgrass (*S. foliosa*) in San Francisco Bay, California, USA." *American Journal of Botany* **84**(5): 607-611.
- Faber, P. (2000). "Grass Wars-- Good Intentions Gone Awry. Why would anyone Bring an Alien Cordgrass into S. F. Bay?" *California Coast & Ocean* **16**(2): 14-17.
- Kittelson, P. M. and M. J. Boyd (1997). "Mechanisms of expansion for an introduced species of cordgrass, *Spartina densiflora*, in Humboldt Bay, California." *Estuaries* **20**(4): 770-778.
- Levin, L. A., C. Neira, et al. (2006). "Invasive cordgrass modifies wetland trophic function." *Ecology* **87**(2): 419-432.
- Rhymer, J. M. and D. Simberloff (1996). "Extinction by hybridization and introgression." *Annual Review of Ecological Systems* **27**: 83-109.
- Smart, R. M. and J. W. Barko (1978). "Influence of sediment salinity and nutrients on the physiological ecology of selected salt marsh plants." *Estuarine and Coastal Marine Science* **7**: 487-495.
- Spicher, D. and M. Josselyn (1985). "*Spartina* (Gramineae) in northern California: Distribution and taxonomic notes." *Madrono* **32**(3): 158-167.