Final Report: May 26, 2004

Facilitation Between Non-indigenous Species: Smooth Cordgrass and Invertebrates

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Proposal Reference Number: 02 T CEQI 03 0102

Introduction:

Many estuaries face the simultaneous threats of habitat destruction and non-indigenous (i.e. introduced) species. San Francisco Bay has lost 80% of its surrounding marshes to development in the past two centuries and has been called the "most invaded" estuary in the world. At the same time, San Francisco Bay provides important habitat for many native species, some endangered, including >500,000 migrating shorebirds each year. In San Francisco Bay and other California estuaries, Pacific cordgrass (*Spartina foliosa*) is the dominant native plant in the lower intertidal zone. In the 1970's, the Army Corps of Engineers introduced *Spartina alterniflora* (smooth cordgrass) from the Atlantic coast to San Francisco Bay to stabilize shorelines. *S. alterniflora* now hybridizes with *S. foliosa*, creating a hybrid that is an extremely good colonizer and competitor (Ayres et al. 1999). Invasive plants have many effects in estuaries, from changing vegetation structure to modifying hydrology, that affect multiple levels of the community. Hybrid *S. alterniflora x S. foliosa* (hereafter hybrid *Spartina*) reduces habitat for native birds and threatens extirpate *S. foliosa* in the southern and central bay and. Both *S. foliosa* and hybrid *Spartina* modify habitat by creating structure on the mudflats; my study examines whether differences in their structure affect organisms living within the marsh.

My dissertation research in Ecology at UC-Davis focuses on changes produced by the spread of hybrid *Spartina* to invertebrate communities, including organisms such as marine worms, crabs, snails, and other marsh species. Infauna (organisms living within the sediment) and epifauna (those that live at the surface) are important to maintaining ecological functions in wetlands because they are important food sources for many species, including shorebirds, and play important roles in recycling organic matter so that it is available to other organisms in the food web. This study examined effects of native *S. foliosa* and hybrid *Spartina.* Study sites included six *S. foliosa* marshes and two hybrid *Spartina* marshes in northern California. *S. foliosa* sites included: China Camp State Park on San Pablo Bay; Bolinas Lagoon; Shields Marsh and Tom's Point on Tomales Bay; Drakes Estero; and Bodega Harbor. Hybrid marshes were located on the eastern side of San Francisco Bay in San Lorenzo and Alameda. The research was comprised of four parts: 1) Comparison of vegetation characteristics between *S. foliosa* and hybrid *Spartina*, and their effects on sediment; 2) effects of the two plant species on infaunal communities; 3) an experiment examining effects of native and hybrid *Spartina* on growth and food sources of a common clam, *Macoma petalum*; and 4) examination of the effects of native and hybrid *Spartina* on marsh food webs using stable isotope analysis. Most fieldwork was completed in fall 2003 and data is currently being analyzed.

Summary of Preliminary Results:

Relative Strength of Native (*S. foliosa*) and Introduced (Hybrid *Spartina*) Cordgrass as Ecosystem Engineers. Both *S. foliosa* and its hybrid are ecosystem engineers that

modify habitat by increasing habitat complexity, accreting sediment, and shading the substrate. This study used a comparative approach to examine differences in vegetation and sediment structure between these native and introduced ecosystem engineers, focusing on canopy structure, biomass, organic content, bulk density, light attenuation, salinity, and oxidation-reduction potential. The results show that hybrid *Spartina* modifies habitat structure more than *S. foliosa* both aboveground and belowground. Hybrid *Spartina* produces greater stem densities, taller stem heights, and greater aboveground (stems) and belowground (roots) biomass. Maximum stem height for hybrid marshes exceeded the tallest *S. foliosa* stem by 43%. Both species significantly reduce light levels and water flow compared to open mudflats. Organic carbon content differed significantly between vegetation and mudflats at some *S. foliosa* sites but not at hybrid *Spartina* sites.

Contrasting Effects of Native and Introduced *Spartina* spp. on Estuarine Infaunal Communities. I hypothesized that differences in physical structure between *S. foliosa* and hybrid *Spartina* found in previous studies would cause differences in density, biomass, and taxonomic composition in infauna and epifauna. Using a manipulative experiment, I examined changes in mudflat sediment transplanted into *S. foliosa*. Although the degree of difference varies by sampling date and site, the overall trend shows that *S. foliosa* contained significantly higher densities and biomass than adjacent mudflats. Total species richness was also higher in *S. foliosa* than mudflats, although species diversity patterns were less clear. Conversely, densities and biomass in hybrid *Spartina* were lower than or not significantly different from mudflats. The most abundant taxa were oligochaetes (tubificidae, enchytraeidae), polychaetes (spionidae, cirratulidae, capitellidae) and corophiid amphipods. The results indicate that although these two plant species are closely related, their presence produces contrasting effects on invertebrate communities.

Effect of Native (*Spartina foliosa*) and Invasive (Hybrid *Spartina)* Cordgrass on Density, Growth, and Isotopic Composition of *Macoma petalum* in San Francisco Bay. Abstract: Ecosystem engineers can influence system dynamics by controlling resources (including space), modifying the flow of energy or biomass, or changing physical characteristics of the habitat. The invasive hybrid cordgrass (*Spartina alterniflora x foliosa*) has changed the physical structure of the habitat and may be changing food webs. I compared abundance, growth, and carbon food sources of the clam *Macoma petalum* among native marsh, hybrid *Spartina*, and mudflats in central San Francisco Bay. I found higher densities of *M. petalum* on mudflats compared to either native or hybrid *Spartina* in all seasons. *M. petalum* shell growth was significantly greater in mudflats than in either vegetation type in 2002 and marginally so in 2003. Differences in growth between native and hybrid *Spartina* were inconclusive. Showed significant differences between seasons in carbon and nitrogen composition of clams, indicating changes in food sources over time, but no differences between habitats. Carbon signatures of *M. petalum* placed in *Spartina* did not resemble the isotopic signature of *Spartina*. Results show that loss of mudflat habitat is the greatest effect of the invasion of hybrid *Spartina* on benthic invertebrates such as *M. petalum* that prefer open mudflats.

Neither native nor hybrid *Spartina* appears to be a significant carbon source for *M. petalum* in San Francisco Bay.

Does invasive cordgrass (*Spartina alterniflora x foliosa*) affect epifaunal food webs?
In its native range on the Atlantic and Gulf coasts of North America, *Spartina alterniflora* enters the benthic invertebrate food web mainly as detritus and forms an important food source for consumers such as mud snails, mussels, and fish. Preliminary results indicate differences between the food sources used by animals living within vegetation and those living on open mudflats. Further analysis will show whether native or hybrid *Spartina* is an important source of carbon for the marsh community.

Conclusions
Hybrid *Spartina* differs from native *S. foliosa* in aboveground and belowground plant structure. These differences affect the organisms living within the marsh and may cause many indirect effects. Although these two species of cordgrass are closely related, they do not have the same effects on intertidal invertebrates. The results of this study have implications for planned marsh restoration projects in San Francisco Bay that will attempt to recreate *S. foliosa* marshes but are vulnerable to invasion by hybrid *Spartina*.

Other Participants:
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Rachael Blake, Nicole Rayl, Mary Pakenham-Walsh, Linda Judah, Tammie Visintainer, Sarah Spilseth (post-graduate researchers, not funded by this grant)

Publications
Publications are currently in preparation.