

Dynamics and Ecosystem Threats of Bidirectional Cordgrass Hybridization in San Francisco Bay

Donald R. Strong

University of California, Davis

Background

Non-native cordgrasses have invaded every restored wetland in South San Francisco Bay. If these grasses, crosses between California's native *Spartina foliosa* and the East Coast's *Spartina alterniflora*, continue to spread, they will threaten the viability of one of the most ambitious restoration projects in the nation. The project seeks to restore 15,000 acres of wetlands—an unusually large area and an exceptionally rare opportunity to enhance habitats for coastal wildlife. This is especially significant in a state that has lost 90 percent of its wetlands and now has 34 million residents, most of them near the coast. The property, before it was purchased by the state and federal governments for \$100 million, was used for commercial salt production.

These non-native cordgrasses are an obstacle to conservation goals because they grow in areas normally unoccupied by grasses. Particularly problematic, they take hold in tidal mud flats, converting these important bird foraging grounds to salt marsh. Besides their ecological implications, the hybrids also dramatically change the landscape by accreting sediments, making it necessary to dredge frequently to maintain navigational channels; the state of Washington spends \$2 million a year to remove hybrid cordgrasses from Willapa Bay.

Research

Sea Grant has funded a series of projects led by biologist Donald Strong of the University of California at Davis to address the many issues surrounding the hybrid cordgrass



Mudflat near Oyster Point, South San Francisco, covering to hybrid meadow. Photo courtesy San Francisco Estuary Invasive *Spartina* Project

invasion. In his earlier work, Strong developed a set of nuclear DNA markers that have made it possible for resource managers to identify and map the distribution of cordgrasses. As hybrids can be nearly indistinguishable from natives, prior to Strong's genetic studies, there was no way of measuring the scope of the cordgrass invasion.

Further genetic analyses showed that there are nine different types of hybrids in the bay. This means that hybrids have crossed with other hybrids, producing impressively hearty and fecund grasses. It is these hybrids, and not the pure non-native itself, which are the true invasives. Strong found that about 98 percent of the cordgrass invasion is due to the proliferation of hybrids. The smooth cordgrass from the East

Coast has not been able to spread on its own.

In other work, Strong tested the effectiveness of killing hybrids with varying concentrations of herbicide, and more recently has looked at why hybrids so easily out-compete other cordgrasses. The reason: hybrids release vastly more pollen, effectively drowning out the reproductive contribution from other plants. This finding has honed eradication strategies. Biologists now remove upwind sources of pollen before attempting to eradicate downwind cordgrass patches.

Outreach

Strong led the "*Spartina* Strategy Workshop" in the fall of 1998, to educate resource managers and scientists about the cordgrass invasion and how to best control it.

His scientific findings have been instrumental in establishing the San Francisco Estuary Invasive *Spartina* Project, a multi-agency task force now in charge of coordinating a regional eradication plan.

Impacts

- Because of this Sea Grant research, the extent and severity of the *Spartina* invasion has been established and can now be monitored.
- The San Francisco Estuary Invasive *Spartina* Project continues to send questionable cordgrass specimens to Strong's lab for conclusive DNA testing.
- The state of California is no longer looking at the mechanical removal of plants as a realistic eradication method. Strong's research shows that herbicide is needed in some places.
- Strong's genetic studies characterizing hybridization processes have been included in the state's eradication plan.
- Based on what has been learned during his Sea Grant research projects, Strong advises that native *Spartina foliosa* should be placed on the Endangered Species list. The genetic patterns he documented in the field point to the extinction of native cordgrasses if action is not taken promptly.

Collaborators

California Coastal Conservancy
San Francisco Estuary Invasive
Spartina Project

Publications and Presentations

- 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. *Amer. J. Bot.* 84(5):607–611.
- Daehler, C.C., and D.R. Strong. 1997. Reduced herbivore resistance in introduced smooth cordgrass (*Spartina alterniflora*) after a century of herbivore-free growth. *Oecologia* 110:99–108.
- Anttila, C.K., C.C. Daehler, N.E. Rank, and D.R. Strong. 1998. Greater male fitness of a rare invader (*Spartina alterniflora*, Poaceae) threatens a common native (*Spartina foliosa*) with hybridization. *Amer. J. Bot.* 85(11):1597–1601.
- Ayres, D.R., D. Garcia-Rossi, H.G. Davis, and D.R. Strong. 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). *Mol. Ecol.* 8:1179–1186.
- Daehler, C.C., C.K. Anttila, D.R. Ayres, D.R. Strong, and J.P. Bailey. 1999. Evolution of a new ecotype of *Spartina alterniflora* (Poaceae) in San Francisco Bay, California, USA. *Am. J. Bot.* 86(4):543–546.
- Wu, M.-Y., S. Hacker, D. Ayres, and D.R. Strong. 1999. Potential of *Prokelisia* spp. as biological control agents of English cordgrass, *Spartina anglica*. *Biol. Contr.* 16:267–273.

- Anttila, C.K., R.A. King, C. Ferris, D.R. Ayres, and D.R. Strong. 2000. Reciprocal hybrid formation of *Spartina* in San Francisco Bay. *Mol. Ecol.* 9:765–770.
- Ayres, D.R., and D.R. Strong. 2001. Origin and genetic diversity of *Spartina anglica* (Poaceae) using nuclear DNA markers. *Am. J. Bot.* 88(10):1863–1867.

Other Projects

- R/CZ-133: Hybridization Between Alien (*Spartina alterniflora*) and Native (*S. foliosa*) Intertidal Cordgrasses
- R/CZ-158: Aquatic Nuisance Species—Initial Steps Toward Eradication of Alien Cordgrass from California Waters
- R/CZ-1PT: Regional Research and Outreach—Control of Nonindigenous (*Spartina alterniflora*) and Hybrids with Native (*S. foliosa*) Cordgrasses in San Francisco Bay

Trainees

Carina K. Anttila
Heather G. Davis
Alison Fisher
Dino Garcia-Rossi
Mary Pakenham-Walsh
Christina M. Sloop
Katy Zaremba

For more information:

Dr. Donald R Strong
Bodega Marine Laboratory
University of California, Davis
Tel.: (530) 752-7886
Email: drstrong@ucdavis.edu

March 2003

This work is sponsored in part by a grant from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, under grant number NA06RG0142, Project number A/P-1. The views expressed herein are those of the author and do not necessarily reflect the views of NOAA or any of its sub-agencies. The U.S. Government is authorized to reproduce and distribute for governmental purposes.



CALIFORNIA SEA GRANT COLLEGE PROGRAM

Russell A. Moll, Director • Dolores M. Wesson, Deputy Director • Paul Olin, Interim Associate Director for Extension
• Marsha Gear, Communications Director

University of California, San Diego, 9500 Gilman Drive, La Jolla, CA 92093-0232
Phone:(858) 534-4440 Fax: (858) 453-2948 Web site: <http://www-csgc.ucsd.edu>