Frequency, Distribution and Ecological Impact of Cryptic Hybrid Invaders: Management Tools for Eradication of Invasive Spartina

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BACKGROUND

Four species of nonindigenous Spartina cordgrass have been introduced to San Francisco Bay. One of them, *Spartina alterniflora*, from the East Coast, has hybridized with the native *S. foliosa* and become highly invasive. These hybrids and their backcrosses are problematic to conservation objectives as they colonize nearly every ecological niche of a marsh – high and low marsh elevations, and across a range of salinities and sediment types. Where established, the hybrids inevitably pollen swap with native Spartina, creating yet more hybrids. With time, rare wetlands can be converted into uniform expanses of grass. Efforts to eradicate invasive Spartina have been based largely on visually identifying the most threatening, biggest, tallest and thickest, red-stemmed, big-flowered cordgrass plants and spraying these with herbicide. The strategy has been highly successful in reducing the invasion's size – from about 800 net acres in 2005 to about 50 net acres in 2011. But, it also appears to have selected for "cryptic" hybrids – cordgrass plants that resemble native Spartina but contain exotic genes.

PROJECT

This project investigates whether cordgrass plants that have evaded or survived herbicide control could be resurgent and stage another invasion. Of particular interest is to address whether plants that look native have the same ecology as native cordgrassses. A closely related goal is to examine whether microsatellite markers can be used to predict a plant's phenotype and ability to become invasive in the future. These topics are being addressed through a common garden experiment and genetics study.

In the garden experiment, 150 cordgrass plants (genets) of known genetic composition were transplanted to a salt marsh at Point Pinole Regional Shoreline in the East Bay Regional Park District, Richmond and planted across five marsh zones below, within and above the native Spartina meadow. Plant growth was monitored from the spring of 2010 to the fall of 2011, along with several environmental parameters, including inundation time, sulfide concentrations, soil oxidation/reduction potential and soil pore-water salinity.

Hybrid Spartina thriving below the lower limit of native Spartina. Credit: L. Feinstein

For the genetics study, the Delta Science fellow tested the resolution and accuracy of a panel of 18 genetic markers, which researchers have been using to find hybrid Spartina, and then isolated an optimal sub-panel of 5 loci that can more expeditiously detect the presence of exotic genes. In ongoing work, these markers are being used to study Spartina's population structure in the bay.

RESULTS

The work to date validates what has been observed in the field and concluded in other research. The cordgrass hybrids found growing in the San Francisco Estuary appear to be effective invaders because they grow faster than, and colonize habitats beyond the range of, native Spartina.

Of the environmental variables monitored in this experiment, soil salinities appear to be the most predictive of cordgrass survivorship. In particular, very saline conditions (observed in autumn) were lethal to all of the transplanted genets, except for some plants in the lower elevations of the tidal mudflat. A year later, these plants were still growing and filling in the mudflat. Genetic testing will confirm whether or not some of these survivors are cryptic hybrids.

The genetics study has shown that cordgrass genotype and phenotype are closely linked: Plants that resemble the native are mostly native genetically. Genetic markers also suggest that there have been multiple introductions of East Coast cordgrass to the San Francisco Bay. The high degree of genetic variability in the exotic species may explain the vigor of its hybrids.

MANAGEMENT APPLICATIONS

San Francisco Bay's wetlands provide habitat to more wintering and migratory shorebirds than any other remnant wetland along the Pacific Coast of the contiguous United States and for this reason are considered of hemispheric importance to bird conservation. Because of this and other conservation goals, the state of California has spent more than $20 million to eradicate invasive Spartina in the bay, and the effort, led by the California Coastal Conservancy's Invasive Spartina Project, has been highly successful. There are, however, currently about 20 sites, representing about 30 net acres, which are no longer being treated with herbicide. Eradication has been halted to protect the endangered clapper rail, which benefits from the presence of some invasive Spartina. This project will inform managers of the risk posed by allowing the remnant Spartina patches to go untreated. The results presented to date suggest that invasive Spartina eradication may not be possible without comprehensive genetic testing to identify cryptic hybrids.

PRESENTATIONS

Ecological Society of America 2011. Evolution of an expanded niche via hybridization: An experimental comparison of the ecological amplitude of *Spartina foliosa, S. alterniflora* and their hybrids.

State of the Estuary 2011. Evolution of invasiveness by hybridization: Comparing the intertidal amplitude of Spartina parents and hybrids (poster).

Ecological Society of America 2010. Hiding in Plain Sight: The challenge of detecting and eradicating *Spartina alterniflora x S. foliosa* cryptic hybrids.

State of the Estuary 2009. Hiding in plain sight: Distribution and genetics of morphologically cryptic hybrid Spartina.

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Spartina alterniflora is a smooth cordgrass from the East Coast. Its hybrids with native Spartina can convert salt marshes into monocultures of grass. Credit: USDA

Cryptic hybrid Spartina. Its short stature and delicate morphology would suggest that it is native Spartina, but its genetics prove otherwise. Credit: L. Feinstein

Delta Science Fellow Laura Feinstein. Credit: UC Davis

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