Spartina Dispatch

Quarterly Newsletter of the San Francisco Estuary Invasive *Spartina* Project

Director's Note

Since last edition, ISP staff and partners have completed draft plans for the next several year's *Spartina* control, and if all goes well with our endangered species review (see p. 2), treatment will begin at many sites by mid-June. Most sites treated last year show remarkable results, and many former mudflats are well on their way to their former biological abundance for foraging shorebirds! We estimate that invasive *Spartina* has been reduced by more than 75 percent baywide.

This edition features in-depth stories on two important topics. The first is *Spartina densiflora*, the second most problematic cordgrass in San Francisco Bay, and a major problem in Humboldt Bay to our north, as well as in Spain (see pp. 1 & 7). We also explore inside the UC Davis *Spartina* laboratory, looking at how the genetics of our hybrid *Spartina* plants are determined. We thank Stephanie Ericson for her excellent work on these stories.

We hope you enjoy this edition of the Dispatch, and that you will join us in looking forward to another outstanding season of *Spartina* control.

Peggy Olofson

Inside

Photo by A. Pickard / USFWS

Spanish biology professor Jesus Castillo examines a clump of *Spartina densiflora* in a Humboldt Bay marsh as Joel Gerwein of the Coastal Conservancy looks on. Castillo is conducting research on the species, which has invaded marshes in southwest Spain and Portugal as well as California.

Another cordgrass

Southwest Spain, Humboldt Bay and Corte Madera Creek share same marsh invader

In the San Francisco Bay, the *Spartina* threat comes almost entirely from one species, *Spartina alterniflora*, and its hybrid progeny. But there is another invasive cordgrass here as well — *Spartina densiflora*. In this estuary, almost all of it grows in the Corte Madera Creek watershed in Marin County. (See Partner Focus, p. 7.)

But in other places, this plant, which is native to South America, has had a far greater impact. In California, it has almost entirely invaded the suitable areas of Humboldt Bay's estuary. In the Gulf of Cadiz in southwest Spain and Portugal, the *densiflora* invasion is even larger.

In contrast to *alterniflora*, this plant is somewhat smaller with rolled narrow leaves. It grows in discrete tufts and produces many more seeds.

Until the 1980s, along the west coast it had been considered a variety of the California native *Spartina foliosa* and not invasive. In fact, in 1976 it was intentionally introduced from Humboldt to Creekside Park in Greenbrae as part of a restoration project, where it subsequently spread to other areas of the 320-acre Marin watershed. ISP estimated that before eradication began, *densiflora* would have covered 12-25 acres if it grew all together in one continous area.

In Humboldt Bay, *densiflora* has in-

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New site plans submitted

ISP has completed proposed treatment plans for each of its 25 control sites and 168 subsites. These site specific plans, covering treatment in 2008 through 2010, were submitted to the US Fish and Wildlife Service in April for evaluation under Section 7 of the federal Endangered Species Act.

USFWS will provide its "biological opinion" analyzing the potential impacts of the proposed work to a suite of threatened and endangered species, including the California clapper rail and the salt marsh harvest mouse, within the next month.

The process is identical to the evaluation of ISP's initial treatment plans three years ago. But at that time few of the *Spartina* stands had been treated.

"Now we have several years of successful treatment, the infestations are becoming smaller and more sparse" said ISP Field Operations Manager Erik Grijalva. "As a result we anticipate that the potential for environmental impacts will be significantly less in the coming three years."

Moreover, observation data collected over the last three years suggest that impacts on clapper rail populations from *Spartina* removal were less than anticipated, Grijalva said. He therefore hopes that the USFWS will allow treatment earlier in the season in many places than was previously permitted.

"It would be great if we could get into the marshes during the height of the *Spartina* active growing season," Grijalva said. "We think we could achieve even better control than is possible in late season treatments."

Continuing seed dispersal study reveals new patterns

Does a buoyant wooden card released in winter ride the waves any differently than one released in spring or summer? A first look at reported sightings of these "drift" cards suggests, not surprisingly, that they do, some traveling much greater distances than ISP's earlier releases.

Last spring, ISP began to study how far and in what directions *Spartina* seeds, especially those contained in large floating mats, might spread by water, using the light biodegradable cards to simulate the seeds' potential movement around and even out of the San Francisco Bay.

Last year, from March through August ISP released over 1,000 drift cards from seven bay locations with invasive *Spartina* infestations.

In December ISP began releasing another round of 1,000 cards from similar locations. While a more thorough analysis awaits reports of more cards in the coming months, some preliminary observations can be made now.

"The drift cards that we released in winter months have shown a greater propensity to migrate out from the bay and move up and down the outer coast much longer distances than we thought they would," said ISP Field Operations Manager Erik Grijalva. "This is in contrast to the ones released in the summer which mostly moved in and around the bay."

Twelve percent of the 120 cards reported by late April were found along the ocean coast both north and south of the bay, with a few more reported near the mouth of the Golden Gate.

"Getting up near Humboldt is striking," commented Grijalva, referring to the card that made its way from Rheem Creek Point in Richmond to Cape Mendocino in Humboldt County. The farthest south that a card traveled was Pomponio State Beach, about 12 miles south of Half Moon Bay.

Overall, releases from south bay locations showed movement to the central east side of the bay, while those from the central and north areas of the bay moved to the outer coast. In contrast, many cards released last summer moved east and south from the west side of the bay.

"We've had wonderful response from the public from the drift card study," Grijalva said. "We intend to continue the work, varying timing and locations of future releases to get a more comprehensive understanding of possible seed dispersal from many sites around the Bay."

SAN FRANCISCO ESTUARY INVASIVE SPARTINA PROJECT

Preserving native wetlands

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The San Francisco Estuary Invasive Spartina Project (ISP) is a coordinated regional effort to address the rapid spread of four introduced and highly invasive *Spartina* (cordgrass) species in our bay.

Established by the California State Coastal Conservancy in 2000, the project is progressing toward its goal of eliminating this aggressive introduced species, working in close collaboration with its many partners around the Bay. This newsletter helps keep our partners informed about project news and activities.

Current ISP funding comes from the CALFED Bay-Delta Program, the California Wildlife Conservation Board, and the California State Coastal Conservancy. Previous major funders also include U.S. Fish and Wildlife Service and National Fish and Wildlife Foundation.

Coastal Conservancy

ISP Partners – Current Grant Recipients

Alameda County Public Works Dept.
California Dept. of Parks & Recreation
California Wildlife Foundation
City of Alameda
City of Palo Alto
City of San Leandro
East Bay Regional Parks District
Friends of Corte Madera Creek Watershed
Friends of Petaluma River
U.S. Fish & Wildlife Service, Don Edwards National Wildlife Refuge
San Mateo County Mosquito Abatement District

Another cordgrass

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vaded 94 percent of the nearly 900 remaining acres of salt marsh wetlands; over half is densely overrun.

Scientists believe that the weed probably arrived to Humboldt Bay in the 1850s from Chile, a country that imported much of its timber then from this bay. Ballast water dumped from ships returning to this California bay could easily have contained *densiflora* seeds that then took root here.

Densiflora's arrival to the Iberian Peninsula may have dated as far back as Columbus' return from America, says Jesus Castillo, professor at the University of Sevilla in Andalusia, Spain. Castillo, who has studied *Spartina* for 11 years, is in California conducting comparative *Spartina* research and learning more about control efforts here.

The arrival of *densiflora* to Spain's Odiel Marshes may have resulted from Columbus using cordgrass bedding for animals transported from the New World and then dumping it into the water as the ships were cleaned, Castillo said. A hundred years or more later, it began expanding from this marsh to other estuaries along the Gulf of Cadiz, a coastline of about 200 miles stretching east from Gibraltar.

Castillo notes how *densiflora*, like its *alterniflora* cousin elsewhere, has supplanted the Iberian Peninsula's native vegetation, including the European native cordgrass, *Spartina maritima*. It changes the physical structure of the estuary to the detriment of other plants, reducing biodiversity. In contrast, *maritima* facilitates ecological succession, Castillo said.

"After *Spartina martima*, other native species come and biodiversity grows over time," he explained. "With *Spartina densiflora* it is the total opposite. It kidnaps the biological succession. It arrives; nothing else arrives later."

Removing *densiflora* where it has almost completely taken over in Spain and Portugal may be futile. However, Castillo hopes the Spanish government will fund efforts to eradicate in areas where the invasion remains small and to set up an early detection network to protect estuaries still free of the invasive weed. This would also include some farmed lands that, with sea level rise from global warming, could become marsh.

A pilot project of *densiflora* eradication by manual removal in 100,000 acres of Spanish marsh was launched in October 2006 and will continue for several more years, efforts that Castillo hopes will be expanded. *Densiflora* plants are dug up, and the area is monitored for new seedlings, which are removed, with native *maritima* planted to replace the invasive cordgrass. In future eradication efforts, Castillo thinks animal grazing could prove useful in limiting *densiflora* expansion in some places.

In Castillo's eyes, the Spanish experience as a sobering lesson to the country's "sister marshes" in California.

"Because the invasion has been in Spain longer, it has spread to eight estuaries, but here you have it only in the San Francisco and Humboldt bays," he notes. "If you don't do anything…. it will spread to other places. This is what happened in Spain."

Fortunately, Californians are taking action, with eradication efforts underway in both bays. As in Spain, the centerpiece strategy here has been manual eradication, which is easier for this species compared with the larger *alterniflora*, whose roots are deeper and more interconnected between individual plants. In the Corte Madera Creek watershed, the herbicide imazapyr is also used in some places.

In Humboldt Bay, the alarm was raised by a 1997 report by the U.S. Fish and Wildlife Service, which manages the 3,200-acre Humboldt Bay National Wildlife Refuge containing a good portion of the estuary's salt marsh.

"For years, the scientific community had been saying, 'it's everywhere it can be, it had filled its niche,…(and) it can't get worse' " said refuge ecologist Andrea Pickart. "Everyone had believed the high marsh was resistant to invasion."

But it did get worse. Of the high marsh plots that USFWS surveyed that year, 40-50 percent had *densiflora* where previously there were none. The discovery eventually spurred several pilot eradication projects.

In 2000 USFWS planted native species in an area and were surprised to discover how well this revegetation slowed down the invasion. This led to a 2004 eradication project, with funding assistance from the California Coastal Conservancy, on 15-20 acres of a refuge island. Since digging was so labor intensive and required filling holes afterwards, they were trying to develop a mowing technique.

"We were able to kill the *Spartina*, with no regeneration, and the native plants began coming back on their own," said Pickart. "It sounded too good to be true and it was."

Another pilot project, also supported by Conservancy funding, followed in 2006, with the same treatment but on a larger scale. Although it killed the *Spartina* here, too, the presence of fresh water at this location allowed seeds to germinate successfully, in contrast to the salt water environment at the earlier island marsh project, Pickart said.

They began killing non-native seedlings by aiming propane torches at them until they sizzled up. They also started mowing lower to the ground, digging a bit into the earth, a technique that helped to reduce seed germination, several times a year. But seed germination varies greatly from one season to another and the reason why is not yet clear.

Photo by A. Pickard / USFWS

USFWS contractor Kristina Prosser, "flames" new *densiflora* seedlings to prevent reinfestation after the plants are mowed down.

Pickart, the Conservancy and others committed to fighting the *densiflora* invasion believe that the only way to conquer the weed is through a concerted regional effort, like that of the ISP. To that end a *Spartina* "summit" meeting was held in March, where participants reviewed the problem and looked at possible treatment strategies.

"These manual techniques have been very successful," said Joel Gerwein, project manager of the state Coastal Conservancy's North Coast Program. "The problem was then having seedlings coming in after the plants were removed. That demonstrated that if we're going to control (the cordgrass),

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DNA lab tackles hybrids

In a small narrow room at the University of California, project scientist Debra Ayres is cutting up some *Spartina* leaves. An unpretentious site of scientific inquiry, this laboratory nevertheless plays a critical role in combating invasive *Spartina*. Called the Don Strong *Spartina* Laboratory for the professor whose active research interest in the plant led to its establishment, it's where Ayres is now preparing to analyze the DNA of the leaf samples collected by ISP field biologists.

To do so, she must first extract the DNA from the rest of the plant material, beginning by grinding the small cut pieces with the help of liquid nitrogen at a cold minus 273 degrees centigrade.

"It's so cold, it allows us to pulverize the samples, so it turns into powder," she explains. It cracks open the nuclei and releases the DNA, but this makes the genetic material vulnerable to the cells' protein enzymes that are ready to digest it.

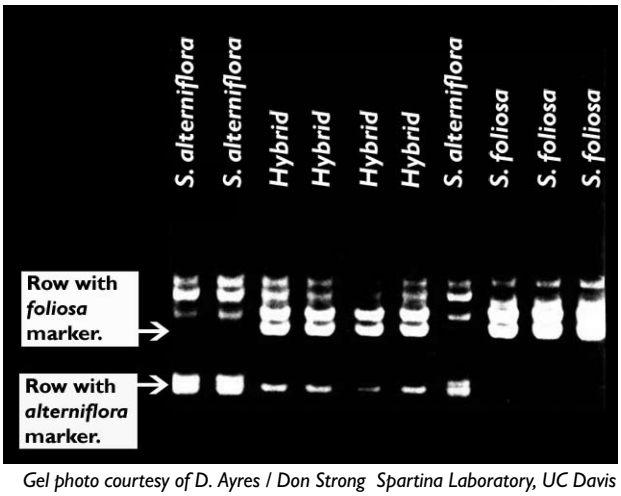
To prevent this she adds a buffer that degrades these digestive proteins, and then, using a centrifuge, separates the DNA material from the rest of the "cellular debris," readying it for the next steps in the process.

Assisted by two undergraduate part-time student employees, and two interns, Ayres' work is a critical complement to ISP's field monitoring of invasive *Spartina* in the San Francisco estuary. It's becoming increasing important in teasing out what is invasive and what is not, as hybrid plants become more varied and harder to identify definitively in the field.

It was a research interest in *Spartina* hybrids —the crossing between the invasive *Spartina alterniflora* and the native *Spartina foliosa* — that led to the laboratory's creation in 1997 by one of Strong's former graduate students, Curtis Daehler. He secured funding and got the lab going, but left for a position at the University of Hawaii after completing his Ph.D. At that point Ayres, with four years experience in molecular biology and a Ph.D. in Ecology, took on the task of upgrading the lab and continuing the work.

Such research helped lay the groundwork for the ISP with the realization that eradication, not simply weed control, was necessary to deal with the rapid evolution of *Spartina* hybrids in the marsh, Ayres says.

Presently the major focus is to assist ISP's monitoring program. Initially, this mostly meant confirming field identification and helping train new field staff as they learned how to distinguish between species. With the reduction in obvious hybrids, says ISP Monitoring Program Manager Ingrid Hogle, ISP is now focusing on the less obvious ones — the cryptic, or hidden, hybrids.



Gel photo courtesy of D. Ayres / Don Strong Spartina Laboratory, UC Davis

In this image, each column represents an individual plant. Rows of bands show the results of DNA fragment separation by molecular weight, with lighter fragments traveling further down a gel slab. Some bands are unique to only one species. A column with bands for both is a hybrid. However, the bands for *alterniflora* in some hybrids are thin and may result in ambiguity.

"We're trying to nip new potential invasions in the bud," Hogle explains. "If we see something that looks slightly suspicious, even just a couple of stems, we want to get it tested." Such testing guards against overlooking plants that don't stand out, but might contain hybrid seeds. It also prevents overreaction to the invasive threat.

"We don't want to be irresponsible with spraying herbicide on sites that look slightly suspicious, if they actually are not hybrid," Hogle says. In the south bay, for example, the native *foliosa* often grows very robustly because of rich soil nutrients, looking similar to the hybrids that grow in central bay areas.

Last year, the lab analyzed over 1,000 *Spartina* field samples, sorting through what is and is not native. But as hybridization proceeds, producing highly backcrossed or "introgressed" progeny — in other words, as hybrids become more genetically "diluted" — even genetic testing is becoming more tricky.

The next steps in the laboratory's DNA analysis helps to explain why. The lab uses a technique called RAPD for Randomly Amplified Polymorphic DNA. The process replicates particular DNA sequences that are unique to one or the other *Spartina* species enough times to be visually identified.

RAPD analysis starts with running a polymerase chain reaction or PCR, in which small snippets of specific DNA sequences, called primers, are added to the *Spartina* DNA. Also added is a special enzyme that acts as a catalyst for DNA replication. This enzyme, Taq polymerase, comes from bacteria that live in scalding thermal sea vents and can withstand the high temperatures needed to separate the DNA into single strands, which allows the replication to occur.

A cycling of heating and cooling allows the polymerase to stitch together the primers where they match up with the DNA strands; the 40 cycles used for *Spartina* DNA produces billions of copies of these fragments, a process known as amplification. The resulting amplified DNA is then applied to a gel using electrical current to stimulate movement. Lighter fragments move faster than heavier ones, so the fragments separate by molecular weight into distinct visible bands. (See photo.)

Occasionally something goes wrong in the process, and a sample "doesn't fire." That's usually not a problem because the lab uses six primers that collectively produce nine bands, each indicating either *foliosa* or *alterniflora* genes. A hybrid will contain markers for both. If one primer fails to amplify a particular sample, usually the others will, and a genetic determination can be made.

However, this year, Ayres is finding

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DNA lab

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that results often include some very thin faint bands, leading to ambiguity in interpretation. It's a possible result of genetic dilution from so much backcrossing, she says. Consequently, she expects the problem to get worse.

Such dilution also increases the chance that a hybrid produces no *alterniflora* markers. In such cases, the absence of any *foliosa* marker would nevertheless indicate that it's not a pure native, but this is weaker evidence than finding an *alterniflora* marker.

Consequently, Ayres is looking for more markers, especially for *alterniflora*, by testing more primers. In her initial selection, she tested several hundred primers over about three years to find ones that would work for these species. Revisiting a few promising primers previously explored and researching new ones could add more markers and reduce ambiguity.

ISP is also investigating using markers of a different type, called microsatellites, to complement the currently used RAPD technique. Microsatellites are "fiddlier" to work with and more expensive, and requires a sophisticated statistical program to analyze, says Ayres.

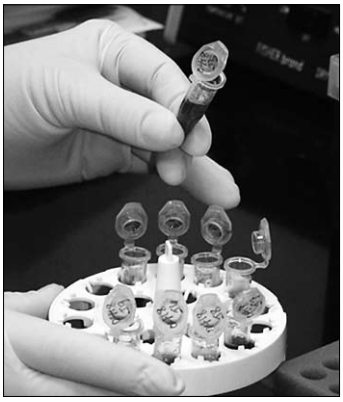
But unlike RAPD markers, they can detect both dominant and recessive members of gene pairs, providing greater statistical power, she says. This provides a greater probability of detecting *alterniflora* markers in highly backcrossed plants.

Just how many markers are needed? UC Davis biology graduate student Laura Feinstein plans to run some computer simulations to find out how many of each type of marker, or both combined, would be needed for accurate genetic determination of an nth generation plant. The more generations considered, the more markers needed. The hope is that the numbers will be something feasible to accomplish.

In these efforts, work at the laboratory is returning to a greater research role, while simultaneously continuing its monitoring work, confirming field sample identification. It's a complementary and collaborative approach that Ayres appreciates.

"I would hope that looking back on this whole *Spartina* issue in ten or 20 years time, people will say…'that's the way it should be done,' where you have the science informing control and this back and forth between science and fine-tuning the control," she says.

"We're not the only lab facing these problems," she continues. "But I think we're the only lab trying to kill hybrid plants…. This kind of application of molecular methods to guide understanding of an invasion and the efforts to control it, I know of no other case where this is going on."



Photos by S. Ericson / ISP

Project scientist Debra Ayres grinds *Spartina* leaf samples with the help of liquid nitrogen to prepare them for DNA analysis. The plant material is next centrifuged, above, to separate out and discard cellular debris. Each tube contains material from an individual plant.

It's a hybrid! But is it invasive?

As hybrids between *Spartina alterniflora* and *Spartina foliosa* cross and backcross over multiple generations, and as the obvious hybrids are eradicated, what's left are increasingly dilute hybrids — plants with small amounts of *alterniflora* genes. Do these still present a threat? Or could invasiveness disappear in subsequent hybrid generations?

Ecology graduate student Laura Feinstein is attempting to find out. Growing *Spartina* at the UC Davis greenhouse, she's first teasing out environmental and genetic effects. Could a cryptic hybrid — a plant that looks like native, but is a genetic hybrid — grow that way because of environmental pressures, rather than its genes? Cultivating the hybrids under a common greenhouse environment should provide answers.

Tackling the question of invasiveness is more complicated and will take longer to resolve.

Feinstein poses the question: "If the hybrids look and act like the native, will we ultimately leave some *alterniflora* genes behind after the control program ends, and it won't make much difference?"

On the other hand, a later recombination of *alterniflora* genes might be far less benign.

"Who knows?" says Feinstein. "Five or ten generations down the road, we might start seeing the invasive hybrids reappear, and it's because it's the product of backcrossing all these other hybrids that were out there." To test this possibility Feinstein will cross and re-cross cryptic hybrids to see if she might produce something that is taller and more robust than the parents, with the potential to be invasive.

The problem isn't simple because genes don't work in simple ways, Ayres says.

"There's no such thing as an invasive gene and a non-invasive gene," she explains. "These are traits that appear because of combinations of multiple genes.… Each one of three cryptic hybrids might contain one third of the necessary materials to make one enormous invasive hybrid, and if you got the right crossings between those you could create something that would be a problem."

Problems in paradise

When ISP biologist Ode Bernstein knocked on the door of a waterfront home in Tiburon last August, he hoped to get a closer look at an invasive *Spartina* patch from the back yard. What he hadn't expected was homeowner Pat Klein's enthusiastic support for ISP's plans to kill it.

Most homeowners need a little convincing first and some are reluctant to have herbicide used on or near their property. But Klein had been trying to get rid of the *Spartina* for years.

Klein lives in Paradise Cay, an unincorporated waterfront community at the foot of the Tiburon Peninsula south of Corte Madera Creek. From Klein's point of view, ISP's interest and intent was a welcome relief. She and her neighbors didn't like the changes *Spartina* had brought to their backyard habitat.

"It's just a small finger of tideland area," said Klein, "and the plants actually inhibit the movement of silt flowing out at low tide. So over the years, we have probably gained about two to three feet of bay mud or silt from the bottom, which makes the channel very shallow."

So shallow that at low tide, there's very little water actually in it. Which means, Klein explains, that the relatively protected little channel — a perfect place for kids to take out a canoe or kayak, says Klein — can no longer host such recreation. The ducks, herons and egrets abandoned the spot as well, perhaps missing the clam beds and mussels that used to be there, she said.

Klein and her neighbors worry about possible flooding when high tide and heavy rains coincide because the *Spartina* chokes the free movement of water. They also don't like the mosquitoes, which have started to breed in pockets of standing water.

"I think if we don't stop it, this entire area will be overrun," said Francine Osenton, Klein's next door neighbor. "We have this small inlet. Once it takes hold it will spread to the rest of the cove … (bringing) stagnant water pollution and disease."

For years Klein has tried to get someone from the USEPA and other public agencies to take an interest, but got no response, she said. She looked into dredging, but found it would be expensive and difficult to get permits. So she welcomed ISP's treatment last summer.

Photo by S. Ericson / ISP

Francine Osenton and her neighbors are dismayed by the Spartina clogging the small inlet behind their homes in paradise Cay.

However, all is not perfect yet in Paradise. Much of the *Spartina* is dead and brown, but still present, and the garbage it traps is just more visible. It all looks horrible, Klein says.

ISP Field Operations Assistant Manager Drew Kerr acknowledges that *Spartina* often decomposes slowly in protected coves with low wave energy, but thinks much of it will be gone within a year. Retreatment this summer will target any remaining live *Spartina*. With more freely flowing tidal water, during subsequent years the sediment build-up will wash out, eventually returning the inlet to its former natural state.

Another cordgrass

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it has to be done on a regional basis." Tidal flows can easily disperse the seeds throughout the bay and beyond.

The Conservancy, which funds several restoration projects in Humboldt Bay, recently committed $175,000 to support more research as well as community outreach and planning over the next two years. Proposals to other funding sources for additional support are pending.

The additional research is needed to better understand the species, the progress of the invasion, and its impacts on the native ecosystems and eradication techniques.

"To get the community behind the regional effort, we need to be able to clearly identify what we need to get rid of," said Pickart. Not everyone finds protecting native plant biodiversity a compelling enough argument, she added.

"We need to know what it's doing to nutrient cycling," she said. "Is it having an effect on fisheries or other components of the ecosystem?" Humboldt Bay has a productive commercial fishing industry that harvests oysters, clams, Dungeness crabs, salmon, albacore, and other fish.

Photos by A. Pickard / USFWS

Densiflora seedlings like this one pose challenges to eradication efforts. Volunteers, right, replace dead cordgrass with native plants. Revegetation helps control *densiflora* spread.

Another issue requiring more research is whether the herbicide imazapyr might play a role. Unlike *alterniflora*, *densiflora* seems more resistant to it, with uneven results where it has been applied in the Corte Madera Creek watershed. While many plants are killed, on others the effects are sublethal. The smaller surface area available to absorb the chemical on *densiflora* leaves may be partly responsible. But application timing may be a factor, too. (See Partner Focus, next page.)

Whether it can be effectively used to halt new seedlings — the key to regional eradication — is not presently known. Furthermore, Pickart says, any treatment with herbicide will be a "hard sell" in Humboldt County. The city of Arcata, for example, has a policy against herbicide use.

"The oyster industry in Humboldt Bay has expressed concern about impacts (from

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Friends of Corte Madera Creek Watershed

As ISP partners go, the Friends of Corte Madera Creek Watershed is unusual. It's not a public agency, for one thing, but rather a successful volunteer-run nonprofit organization overseeing an array of environmental education and restoration projects in this Marin watershed area.

For another, it confronts somewhat different challenges in *Spartina* treatment. Elsewhere in the San Francisco Estuary the invasion is comprised almost entirely of *Spartina alterniflora* and its hybrid progeny. However, Friends mostly confronts an invasive sister species, *Spartina densiflora*, which has somewhat different characteristics. (See Another cordgrass, p. 1)

Finally, largely related to this species variation, the group gets rid of *Spartina* more through digging than spraying. Sound daunting? Try digging out large plants in the mud during a January rainstorm. Well, actually, it's worse on a hot day in late summer, says Sandra Guldman, the very active president of the group and one of the driving forces of Friends' *Spartina* eradication program.

"Driving rain is the least of your problems because you suit up in your rain gear," Guldman comments. "And it's easier to keep clean — the mud washes right off." In summer the mud dries on both people and tools and is tough to remove. And, of course, it's hotter.

Endangered California clapper rail inhabit a large portion of *Spartina*-infested sites here. So most treatment occurs between September and January to avoid disturbing nesting pairs and their hatching offspring, but areas where rail have not been observed can be treated in July.

Friends' first efforts began in winter 2003 in Piper Park of Larkspur, where there' was a good-sized infestation of scattered plants in the high marsh plain. After a small dry run, then-ISP Monitoring Program Manager Katy Zaremba and Guldman led volunteers, including 30 members of the Marin Rowing Association and some of their parents, in removing a large amount of the invasive weed at the park.

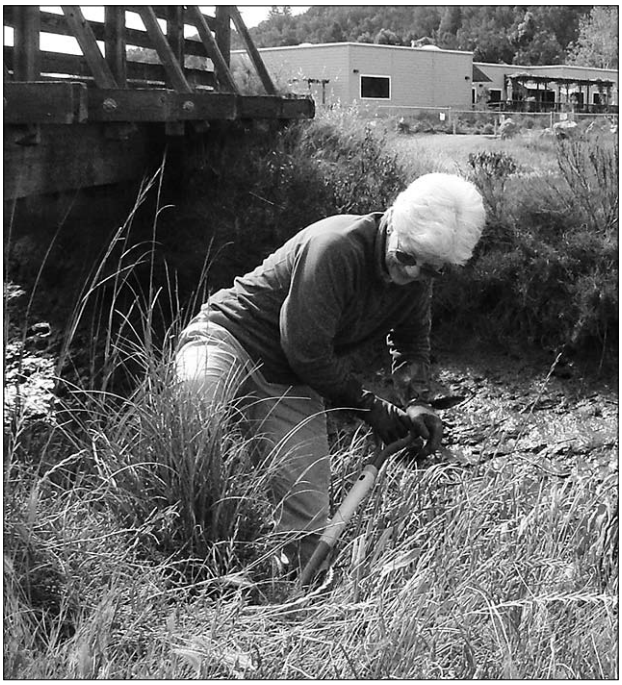

Photo by S. Ericson / ISP

Sandy Guldman, president of Friends of Corte Madera Creek Watershed, digs out one of several modest-sized *densiflora* plants on the College of Marin campus.

Presently most of the actual digging is performed by the Marin Conservation Corps with Friends' coordination and oversight, funded by the California Coastal Conservancy. The Corps, begun in 1982, provides year-round vocational and education programs for youth and young adults, emphasizing local natural resource and conservation efforts.

While overseeing this work, Guldman often will talk to curious passersby, educating them about the *Spartina* threat and the project's efforts to counter it.

Friends' volunteers still do some of the manual removal, however, especially where both number and size of the plants are small. Digging up *densiflora*, while not exactly easy, is feasible because its roots are shallow and separate between the individual plants, unlike *alterniflora*'s interconnecting root system, explains Drew Kerr, ISP Field Operations Assistant Manager.

Moreover, so far at least, chemical treatment appears less effective on *densiflora* than on *alterniflora*. This may be because the timing of summer applications occurred late in *densiflora*'s life cycle. *Densiflora* flowers about two months earlier than *alterniflora*.

However, digging is not practical in some places because of difficult terrain, the size of the infestation, or the presence of *alterniflora*. Contractors have applied herbicide using backpack sprayers at such locations since 2006. This includes Creekside Park, where *densiflora* first took root in the watershed some 30 years ago and became a dense cordgrass meadow.

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Another cordgrass

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imazapyr) to the free swimming larvae stage of their operations… and I'm not sure if research (thus far) has conducted those tests," Pickart said. Other segments of the community are also concerned, she said.

"We hope to proceed by looking at both methods separately and together, but before we can even experiment, we have homework to do on these questions," she said.

Meanwhile, efforts are underway to come up with a plan that covers all the agencies and private landowners that would need to be involved. Gerwein anticipates that a locally based entity would take up the challenging task of coordinating regional control, with Conservancy support.

"I don't see us swooping in and doing it in a year or two, but more in a phased manner," commented Pickart. "Doing it all at once may be too much." Rather, she says, even initial treatment might be applied over several years to different parts of the estuary.

"But that's what these two years are for," she said, "to figure out the best methods and how to apply it in a regional way."

Friends

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Herbicide use is controversial in Marin, notes Guldman, but the group's history and continuing use of manual treatment led to community acceptance of chemical treatment.

"When we spray with the herbicide, people appreciate that we've made an effort to minimize this type of treatment," Guldman says.

"The group was already a respected member of the community and viewed as a responsible steward of the watershed," Kerr comments. "So their assessment that this problem needed to be addressed allowed the broader Corte Madera community to accept the project."

In contrast to other ISP sites, where infestations exist mostly on large public lands, here they affect many individual residential and commercial parcels. Educational outreach was therefore a key component of the group's work.

"They have the largest number of adjacent landowners and highest number of notifications required, and therefore the greatest number of potential challenges," Kerr notes. "It's a huge undertaking to get landowner permissions. Friends is truly the only reason the project is as far along as it is in that part of the Bay."

Lisa DiGirolamo heads up the work of outreach in the community. In addition to posting signs, the group individually notified approximately 1,500 owners of properties within 500 feet of any treatment site before any such work began. Where *Spartina* is on private property, she obtained written permission to treat from the owners.

In public meetings and site visits, DiGirolamo met with owners to discuss any concerns. Keeping up with landowner turnover and getting in contact with people was often challenging, but with help from friendly neighbors, the needed treatment permissions were usually obtained.

"We actually got a surprising number of permissions," said DiGirolamo, "I thought herbicide use would have been a bigger issue than it was. We also offer manual removal to give everyone a choice… but most went along with (spraying)." Friends also replaced *densiflora* with alternative native marsh plants at some properties.

However, about ten owners still oppose even manual treatment for a variety of reasons, including erosion concerns, the plant's function as a debris "fence," and strong property rights attitudes. DiGirolamo and Guldman worry that allowing *Spartina* to remain at these properties will eventually reinfest other areas, so negotiations continue.

Photo by S. Guldman / FOCMCW

Members of a Marin Conservation Corps crew remove *Spartina* on Berens Slough in Kentfield.

Eradicating the invasive cordgrass has proceeded more slowly than Friends had first anticipated. New seedlings spring up and some treated plants remain alive. So DiGirolamo must now renew expiring three-year permissions from about 200 property owners for another treatment season.

Nevertheless the infestation has been reduced substantially, Kerr says; a full assessment of last year's work will be possible in the coming months.

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