Invasion of the Bay Snatchers

Local scientists battle aquatic invaders that quash biodiversity and threaten state coffers.

By Eric Simons

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Erik Grijalva stands on a levee on the Hayward shoreline, hands on hips, surveying the surrounding acres of blackened, rotting plant stalks with the air of a man who is incredibly pleased with his work. "This looks great," he says, nodding at the scarred remains of the meadow.

Andrew Cohen IDs a bay creature.

California's aquatic invasive species management plan describes the Asian swamp eel as a "voracious predator." It is currently a problem in Georgia, Florida and Hawaii.

Grijalva and Kerr survey the damage.

Namalycastis abiuma a.k.a. the nuclear worm originally hails from Vietnam's river deltas.

Grijalva and colleague Drew Kerr are weed-control specialists on a major scale, and their current task is a rather audacious attempt to save sixty thousand acres of San Francisco Bay shoreline from a fast-spreading East Coast cordgrass called spartina. Central to their plan is the mass application of herbicide to thousands of acres of bay marshes, which they hope will eventually eliminate one of the Bay Area's most extraordinarily successful invasive species. "This time last year, this was all green and happy," Grijalva says, waving at the dead plants. "We were very concerned about being able to treat it. Now that we see it, we're very pleased."

Which begs the question: What's wrong with green and happy, even if the green and happy plants aren't from these parts? Why throw millions of dollars and thousands of hours at the problem, when one species outhustling another is the whole idea that got that guy Darwin famous? Shouldn't we simply, as the famed British philosopher McCartney said, let it be?

This is a common query, and one that complicates life for everyone working to keep invaders out of the bay. The short answer is that many of these travelers, spartina included, are major destructive nuisances that spread rapidly and blot out the biodiversity around them. Spartina is just the green-and-leafy tip of things. Aquatic invasive species, many scientists agree, are the biggest environmental problem you've barely heard of. They're also one of those problems that, left unchecked, could end up costing us huge sums of money. The San Francisco Bay, by many accounts, is one of the planet's most-invaded aquatic ecosystems. It is so thoroughly colonized that most prevention efforts now focus on keeping new invaders from displacing long-established ones. The leading scientific study of the bay's invasive species, a 1995 survey by biologist Andrew Cohen, notes that it's difficult, if not impossible, to find things in the bay that were around two hundred years ago. Try it yourself: Head out to a dock, grab a fistful of stuff from a piling, and sort through it. Maybe you'll get some Japanese sea squirts, or an Atlantic sea slug, or some exciting, flame-colored red-beard sponge from Nova Scotia. Whatever you find will be a far cry from what you would have pulled out two centuries ago — not that we even know what that was. "We should spend more time thinking about that," says Cohen, who runs the biological invasions program at the San Francisco Estuary Institute, an

Cohen has catalogued more than two hundred exotic bay invaders.

Details:

Read more on the Bay Invaders: Spartina!, Hydrilla!, The Overbite Clam!, The Nuclear Worm!, The Asian Swamp Eel!

Oakland-based nonprofit.

For example, Cohen has been reading reports from the 1830s about people collecting octopuses from the bay. The mollusks were said to be so plentiful that people walked along the shore with bags and pulled them from tide pools. "I've never seen an octopus in the bay, and I don't know anyone who has," Cohen says.

Some exotics don't cause problems. But others do: Spartina, European green crabs, Chinese mitten crabs, the ominously named water plant hydrilla, Australian oyster drills, Asian worms, New Zealand snails, and the entrenched Asian clam, to name a few. "You're not going to be able to get the Asian clam out without killing everything," says Karen McDowell, an environmental planner with the state-run San Francisco Estuary Project. (See sidebars: **Spartina!**, **Hydrilla!**, **The Overbite Clam!**, **The Nuclear Worm!**, **The Asian Swamp Eel!**)

Each of these invaders graces the bay or delta with its own suite of destructive tendencies — clogging pipes, fouling ship hulls, choking off water surfaces, altering the food chain, introducing parasites, or reengineering the immediate environment to suit its needs. One by one they're nuisance enough, but taken together, invasive species place major stresses on the bay ecosystem.

Among the biggest concerns is the uncertainty that creates: Scientists just don't know what the outcome will be, and because the bay is changing so quickly, it's hard for them even to keep tabs on it. "It's like the global warming change," says McDowell, who is overseeing the drafting of California's aquatic invasive species management plan. "Eventually, if we do enough damage to our aquatic environment, people will wish we hadn't."

The Asian clam — which Cohen says should be called the overbite clam, since there are actually several varieties of clams from Asia — is a good example of a reckless environmental engineer. For roughly two decades, scientists had studied the fairly stable ecology of the North Bay, and its annual summer phytoplankton bloom that constituted the base of the food chain for many bay critters. In 1986, the overbite clam arrived, probably after being dumped with a ship's ballast water. The mollusk, which sucks in and filters the surrounding water of nutrients, began to multiply rapidly. By 1988, its bay floor density was estimated in some places at fifty thousand clams per square meter. That same year, the plankton bloom disappeared entirely, possibly for good. Clams one, science zero.

Invasive species experts also fret about the baddies that aren't here yet but may be on the way, such as quagga mussels, an East Coast scourge discovered in a Southern California lake this past January. If quagga mussels make it to Northern California, they are likely to clog up the pipes of the State Water Project, which supplies drinking water to 23 million people and irrigation for the Central Valley's multibillion-dollar agriculture industry. The mussels spread so fast, grow so thick, and filter so many nutrients from the water that they also are expected to wreak havoc on local species such as salmon and Delta smelt.

Quaggas and their close relatives, zebra mussels, "are two of the most devastating invaders to arrive in North America," says Cohen, who is leading the state's scientific response to the threat. "They're responsible for hundreds of millions of dollars of straightforward economic damage on the East Coast, and there's no reason to think it'll be any different here on the West Coast."

A lot of that damage has been to nuclear power plants, which tend to have their underwater equipment clogged by mussels, but quaggas also attach to boat hulls, docks, breakwaters, navigational aids, firefighting and air-conditioning systems, water treatment gear, and so on. Quagga and zebra mussels have also threatened or destroyed native species of fish and shellfish, especially in the Great Lakes region, and left nearly barren water behind.

Cohen says he's recommended that the state attempt to eradicate the quagga mussels from Lake Havasu before they spread. Just consider that for a moment: He wants to exterminate colonies of one-inch mussels hidden who knows where within a large lake that's popular with recreational boaters. "It's daunting, and to many people it's insane," he says. "But we need to think on a military kind of scale about this thing. If you think at that scale, it's entirely possible."

While quagga mussels top the list of Things That Aren't Here Yet but Could Be Soon, several other potential

invaders operate at a slightly less worrisome scale. These include giant Salvinia ferns ("one of the world's worst aquatic pests," the state's draft management plan says), Asian swamp eels, Chinese snakeheads ("a voracious predator"), and, strangest of all, a hot-pink, six-foot-long Vietnamese annelid known as "the nuclear worm," which fishermen like because they can easily cut it up for bait. "The nuclear worm is the biggest, baddest worm on the block," Cohen says. "We don't even really know what it is, except it comes from somewhere like the Mekong Delta."

So far, angler education (and probably a healthy squeamishness about giant pink critters) has kept the worm away. In many cases, educating people, especially boaters, about invasives is the only strategy available. Once something like the overbite clam gets established, it's unstoppable, and scientists have to hope the altered ecosystem remains stable long enough to study before a new invader moves in. Cohen can't even estimate the long-term cost of so many invasive species. Instead, he worries in the abstract: He speaks of potential "multiplier effects," "overload," extinctions, habitat loss. "With wholesale alteration of the environment, there's almost anything that can happen," he says.

On a recent morning, Andrew Cohen is sprawled on his stomach on an Alameda boat dock. Looking down at the underwater portion of the pilings, he laments a long-ago trip where he lost his eyeglasses to the depths. "I should have bungees or something," he says with a sigh, "but I'm just terrible at personal equipment management."

The biologist rips a handful of marine life off the piling and dumps it into a white plastic tray for inspection. He pulls out a "crust-of-bread sponge" from the East Coast. "Supposedly smells like sulfur," he says, squeezing and sniffing the brown, salty-smelling, finger-size tunicate. He grabs some red-beard sponge, also from the Atlantic, and teases out its waving red arms with a mud-slicked finger. He whips out his pocket lens to examine a tiny translucent shrimp from Japan. "It looks like a creature from Mars," he says, pointing at its three back legs and the pouch where it stores its young. "Just fascinating under the microscope."

There also are bryozoa from Florida, seaweed from Japan, and a tiny colony of beautiful orange petal-like sea squirts from France, which traveled to British Columbia before spreading down the coast all the way to Baja. What's missing are the native species. The California representatives amount to a couple forms of seaweed (which may or not actually be local), some local barnacles (which have turned the tables and invaded Argentina), and a native oyster in the process of being killed by a nonnative oyster drill from Australia.

Cohen has authored what are widely considered the seminal studies of invasive species in the bay: He conducted a 1995 survey that amounted, essentially, to a roll-call of the bay's varied expat aquatic communities, and published a 1998 paper in *Science* magazine that concluded the rate of invasion was accelerating. He counted 234 exotic species in the bay and delta in 1998, and compiled a guide that can be downloaded at ExoticsGuide.org.

These days, Cohen says, the exotics probably number around 275, but that's just an estimate — he hasn't been able to find money to update the survey. In the world of environmental funding, invasive-species research gets chump change. Consider the National Oceanic & Atmospheric Administration, which, according to Cohen, is one of the top grant-givers. NOAA offers a paltry $50,000 for annual invasive species research in the western United States — an area stretching from the Rocky Mountains to Guam — and just $250,000 for the entire country.

As a result, few environmental groups can spare staff time to study the problem. "Invasion for a decade has been on everyone's lips as one of the three or four most critical issues," Cohen says. "Now all of the environmental groups list it as one of the key stressors, but no one's got a dedicated hour. Everyone agrees it's a big problem, but there's no funding, and no attention."

Cohen, however, is transfixed. He can't walk past a body of water without checking to see what's there. He leaps with delicious squelches into mud and muck to pull out dripping fistfuls of clams and sea slugs, and comfortably rattles off scientific names and terms like "underlying gelatinous matrix" to describe the sea squirts coating the underside of a rock.

On this morning, besides checking out Alameda docks, he wanders along the Oakland estuary at the base of the Fruitvale Bridge and surveys the exposed sand on Alameda's Crown Beach at low tide. By day's end, he's found 65 species, of which 41 are exotic, 16 native, and 8 of unknown origin. One milky, slimy lugworm egg case appears to be of a species previously unknown to the bay.

It's not that quarter-inch sea squirts present some huge threat to our collective future, but even the less harmful

invaders help contribute to the decline and extinction of local species, and rapid changes in the bay environment.

Some of the species do affect people directly, such as the egg case of the Japanese bubble snail Cohen pulls off the underside of a rock near the Fruitvale Bridge. This yellow-dotted egg case carries a parasite called a schistosome, or flatworm, that typically embeds itself in the legs of water birds. Sometimes, Cohen says, it also will burrow into the exposed skin of waders or, say, biologists who stick their hands in the water.

Unlike many schistosomes, this one doesn't target humans deliberately, but it does cause a fairly nasty rash called "swimmer's itch," similar to poison oak. There was an outbreak at Crown Beach in 2005, with more than ninety people reporting rashes after wading. This particular problem doesn't have much of a solution because, like the crabs, clams, mussels, squirts, and seaweeds, the Japanese bubble snail isn't going anywhere.

While spartina doesn't specifically target people either, it does make a mess of expensive human conservation efforts. There are several cordgrass species around the bay, including one native species that's quite crucial to its local environment. But spartina became a problem in the 1970s. The Army Corps of Engineers was breaking levees to let the tides back into some former commercial salt ponds in Hayward and Fremont, and wanted fast-growing vegetation to aid the transformation. They discovered that an East Coast cordgrass variety seemed to spread quickly, so they planted it.

Let's just say their plan worked. The Atlantic species quickly crossed with the local cordgrass to create what scientists ominously label a "hybrid swarm." The new plants have varying traits and can adapt to all sorts of conditions. They fill up habitat-crucial mudflats where the native cordgrass doesn't go, fill in natural salt ponds where the native cordgrass can't live, and outcompete everything else. Left unchecked for a few years, the swarm eventually displaces all other plants, leaving marshes as homogeneous as Nebraska cornfields. This is bad news for restoration efforts around the bay. Conservationists have long dreamed of breaching industrial levees and letting the tides replenish what were once vast bay marshes and wetlands. But spartina has forced the US Fish and Wildlife Service, which oversees most of the salt-pond restorations in its 30,000-acre Don Edwards San Francisco Bay National Wildlife Refuge, to push back plans for breaching levees at several major sites.

Many of those projects are decades in the making and tantalizingly close to success. They've been touted in the media as incredible victories for restoration, and among the boldest environmental projects ever accomplished. But if they proceed before the spartina is eradicated, the hybrid swarm will destroy them.

For the biologists and bureaucrats involved, this is a source of great frustration. At Bair Island in San Mateo County, for example, civic-minded locals have worked for decades to ensure that the former Cargill salt ponds would revert to wetlands. Now, because of spartina-related delays, restoration project managers worry that the elderly volunteers who have worked so hard to preserve Bair Island may not live to see the result. "Biologically, everyone understands it makes sense, but I just want to make sure they can appreciate the fruits of what they worked so hard for," says Clyde Morris, who manages the refuge.

Still, he acknowledges, there's really no other option: "If we restore it without considering invasive species, including spartina, and end up not successful, I should be fired."

It's not just Fish and Wildlife lands that are affected. Peggy Olofson, director of the Berkeley-based Invasive Spartina Project, says shoreline developers are often allowed to eliminate wetlands in exchange for creating new ones elsewhere — a practice known as wetland banking. But because there are typically few restrictions on where and how the new marshes are established, spartina often takes them over, leaving behind yet another target for the Spartina Project. "Big developers are allowed to develop because they're theoretically creating new wetland," Olofson says. "That mitigation is essentially worthless. And that bothers me."

Spartina perfectly demonstrates the high cost of ignoring an invasive species until it becomes a major problem. Because it poses a threat to long-term, politically popular restoration initiatives, the Invasive Spartina Project, unlike most invasive-species efforts, is flush with funding. It launched in 2005 with $600,000, secured $1.5 million for its second year, and $2.25 million for this year. It likely will get more next year, somewhere in the $2.5 million to $3 million range, since the group keeps discovering new infestations. Olofson's mission: Search and destroy. "'Controllable' is not a word that can be used with hybrid spartina," she says. "Our goal is to *eliminate* all visible and discoverable hybrids."

She pulls up an image on her computer that resembles a postapocalyptic nuclear wasteland version of the

Alameda shoreline, full of scorch marks and what look like black, sprawling impact craters. The craters are "treated" spartina — areas the group has sought out, targeted, and bombed with herbicide. "It's kind of like death and destruction here," Olofson says. "And we're so happy."

There are a couple of general strategies for dealing with things like invasive species. You can treat first and ask questions later, or, as the state's draft management plan puts it: "The best analogy may be that of a war, when it is often desirable to strike quickly, before much ground is lost."

That's when you sit down and explain what you did, knowing that at least the problem is solved. At least in theory. This was the state's strategy in the late 1990s, when nonnative pike showed up in Northern California's Lake Davis. The state worried that the voracious predator would spread to threaten or even destroy salmon and other fish in the Delta. Without pausing for much consensus-building, the state Department of Fish and Game lowered the water level and poisoned the entire lake, killing everything except, somehow, a few pike, which survived to ensure future problems. The natives — people, that is — were displeased with the strategy, to say the least.

The Invasive Spartina Project took the opposite approach, conducting extensive research before its members set to work with the herbicide. In 2004 Olofson's group hosted a convention of invasive-species experts from around the world. On the final day, they took some of them on a bus-and-helicopter field trip to see the scale of infestation around the bay and recommend a course of action. Alarmed, the experts directed Olofson to move quickly. "They told us, 'It's not too late, but you're going to have to be really aggressive,'" she says. "That's basically our marching orders. Be aggressive."

The avalanche of project-justifying paperwork produced by Olofson's nonprofit won over most opponents. By the time the nonprofit began its large-scale herbicide spraying in 2005, it had the support of major Bay Area environmental groups, and tacit agreement from groups that were more uncertain about the herbicide use.

Olofson says it was Baykeeper, the organization that most closely monitors pesticide and herbicide runoff in the bay, that actually suggested the herbicide her group uses. Marilyn Latta, Save the Bay's restoration director, is also on board. "We recognize that the issue has become so bad for the environment that it's a better choice to do the spray program and try and control the hybridized plant," she says.

One spring morning, Olofson sits in a loft at her group's Berkeley office, consulting with Ingrid Hogle, her monitoring director. Hogle, just back from a trip to the North Bay, pulls up on the computer an aerial photo of the Petaluma River, snaking down through Marin County. Small red dots are overlaid on the image. Olofson leans closer.

Hogle warns that Olofson won't like what she sees. The dots are confirmed spartina hybrids, and there are a lot of them. They are clustered around an area where boats, including ones that work in spartina-infested areas of the East Bay, dock and rinse off. Hogle and Olofson scroll down, moving the map toward a wide, undeveloped area. The director looks at once alarmed and excited. "Just down from this is the Petaluma Marsh," Olofson says. "It's a jewel. Thousands of years old."

She falls silent, and both she and Hogle look at the marsh on the map, with the red dots hanging right over the top of it. "That means that anything coming out of that harbor is a potential vector," Olofson says.

"I didn't tell Peggy this on Friday," Hogle mumbles, still staring at the computer, "because I wanted her to have a good weekend."

"It just makes my heart go ..." Olofson breaks off, thumps rapidly at her chest, then continues mournfully, "I just want to stop time."

A month later, Olofson lays out the big picture for an audience at the Oakland Museum. By this time, the Petaluma invasion has been confirmed, and Olofson has set up a monitoring and treatment plan with Friends of Petaluma River. It looks better than it did at first, she says. With some luck, the infestation might be eliminated in a few years.

The first part of her talk focuses on broader environmental concerns: The bay is shrinking. Tidal marshes are being filled in. Sediment is increasing. Water quality is suffering. Fish are in decline.

Then comes the clincher: Of what were once tens of thousands of acres of "prehistoric marsh" — wetlands dating back at least five hundred years — only three pieces remain: about 1,000 acres of Suisun Marsh at Rush Ranch. A bit less than that at San Pablo Bay's China Camp. And about 2,800 acres of Petaluma River Marsh.

And now here come those little red dots.

That's where Grijalva and Kerr, the ground troops, come in. Together with Olofson and Hogle, they use aerial photos, marsh surveys, and GPS mapping to identify infestations and bomb the plant into submission.

Spartina grows tall and green in spring and summer, then flowers, seeds, dies, and turns brown in winter. Since local contractors apply the herbicide in midsummer or early fall, Grijalva and Kerr have to wait until the following summer to see what grows back before they know how well their treatments worked. They're looking for short, black, and rotten — "stubble," they call it — as opposed to green and springy, a symbol of failure.

For the last two years they've used an herbicide called imazapyr, which attacks amino acids found only in plants and doesn't generally harm humans or animals. It also wipes out other plants, or at least it would if the spartina hadn't already done so. They're finding the chemical works best on the second go-round. "When you come back the next year and hit it again, it's taken all its energy to withstand the first year," Grijalva says, "and it just gets hammered."

On a cloudy day in May, Grijalva and Kerr bounce along a levee road in Grijalva's blue pickup, heading for ground zero. Salt pond 3A is the place where Atlantic spartina was introduced, and the nearby flood control channel is how it spread. They two are coming to see what's grown back in an area targeted last year for heavy bombardment via helicopter.

Small rocks bounce and fly off the road, and a pair of mating birds flutters away from the oncoming truck. The levee runs west toward the bay, and separates the restored salt ponds from the Alameda Creek flood control channel, both of which are lined with blooming yellow mustard grass and short, green native pickleweed. Rabbits race away into the spartina, which grows here to disconcerting heights of eight or nine feet.

The flood control channel bends toward the horizon, where it's clogged with a thick wall of hybrid spartina. Almost all of the plants, though, are blackened and dying, and while there are still some areas where green shows through underneath, Grijalva and Kerr exult. "There's a lot of dead spartina out there," Kerr says. "A lot. Seventy, eighty percent. It looks great."

The pair say they think the cordgrass may have been reduced by as much as 150 acres. As they point out bits and pieces of exposed mudflat that wouldn't have been there two years ago, their mood improves further. As efficient an invader as it is, the plant — at least in this browned and rotting neck of the marsh — seems to have run up against an even more effective gardener. "This is one of the most established infestations," Grijalva says. "Hitting it and having it work was great for the psychology of our partners. Everybody who looked at this said, 'How are you going to do this?' Even I thought, 'Shoot, how *am* I going to do this?' But it works. It really works."

Before they pile back into the truck, Grijalva and Kerr take a quiet, triumphant moment, allowing themselves to feel like they've gotten the upper hand. But both know better. On the drive out, they're already looking at what they'll have to hit next year to prevent a comeback. If this were a bad horror movie, the camera would probably pan out and up to reveal a blackened area amid a vast sea of green — apt foreshadowing for a sequel, and a warning of what to expect if the vigilance of the protagonists ever ceases.