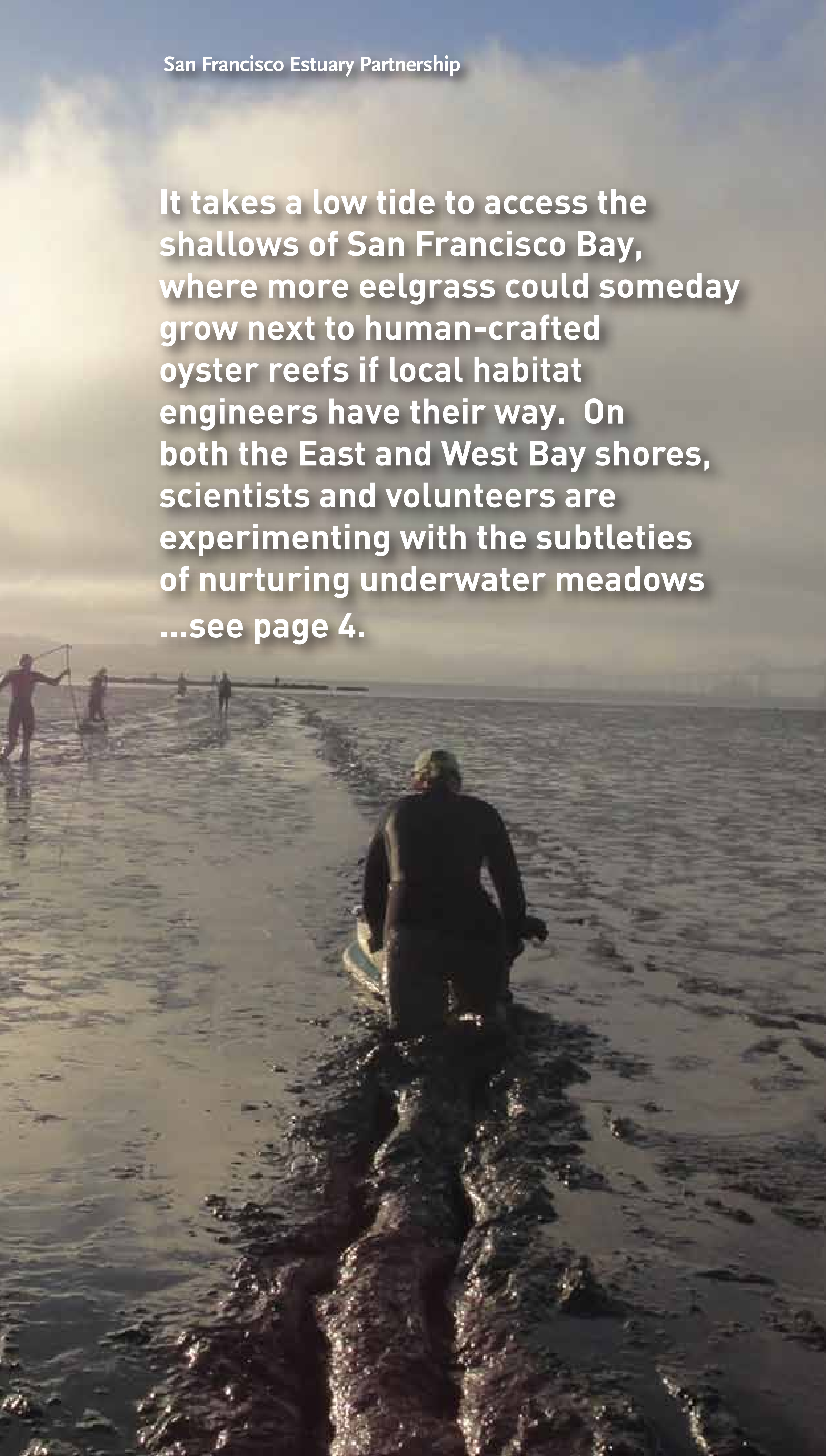
San Francisco Estuary Partnership



**It takes a low tide to access the shallows of San Francisco Bay, where more eelgrass could someday grow next to human-crafted oyster reefs if local habitat engineers have their way. On both the East and West Bay shores, scientists and volunteers are experimenting with the subtleties of nurturing underwater meadows** **...see page 4.**

SCIENCE • RESTORATION • WATERSHED • POLITICS • SPECIES • BAY

# ESTUARY NEWS

NOVEMBER 2012
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WATER SHED

# Trailing the Mokelumne

The best way to experience a watershed is to hike it, source to outlet. That may be possible one day on the Mokelumne Crest to Coast Trail, which follows its namesake river, and has been over 20 years in the making. A crucial 29-mile segment across East Bay Municipal Utility District land in the Sierra foothills opened on October 6.

Photo © Carolyn Fox

Launched by an equestrian group that spun off the Mokelumne Trailbusters, trail construction has relied heavily on volunteers —14,000 hours over the last two decades for the Mokelumne area alone. The project also enlisted California Conservation Corps, California Youth Authority, and California Department of Corrections crews. Financing came from taxpayers (Propositions 12 and 84), the California State Trails Program, and EBMUD.

The District's Kent Lambert says the 26-mile stretch that's already open gets moderate use from riders and hikers — 58,000 users since 1992 — and has hosted 50-kilometer footraces and equestrian events. It follows the river, winds around Pardee and Camanche reservoirs, and traverses north-facing slopes through oak savanna and woodland. "There's lots of available shade in some stretches," he says. A group horse camp at Turkey Hill will provide overnight accommodation.

The trail is still a work in progress. Lambert says the trail council is moving down the watershed to work with other organizations on the connection across the Sacramento-San Joaquin Delta. **JE**

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R E S T O R A T I O N

# Cullinan's New Crust

On a drive by, Cullinan Ranch looks more like construction zone than a restoration site. The hay and oats grown here by farmers for more than a century are long gone, and once the earthmovers are done reshaping the site, there'll be a breach in the dike the farmers built to drain the property too. As tides reclaim the ranch, it's hoped that native plants and animals—including federally endangered species — will recolonize this vital piece of the San Pablo Bay National Wildlife Refuge.

It's been a long time coming. The US Fish and Wildlife Service acquired the 1,500 acres of former farmland in 1991, after it escaped development as "Egret Bay." "We always knew what we were going to do," says refuge manager Don Brubaker. "It was a matter of getting the money." There was one unforeseen problem. "Initially we thought we could just punch holes in the levee and restore hydrology to the site," recalls Renee Spenst of Ducks Unlimited, a key partner in the process. "Then we discovered seven-tenths of a mile of Highway 37 would be flooded during extreme high tides, with winds pushing the water level higher." Sea level rise would make it worse. Even today, Brubaker says king tides accompanied by storms can reach the highway.

The fix, started last October, required a setback levee. "We piled up material, and now we're compacting it in place," Spenst explains.

Brubaker likens the process to "kneading a 3,900-foot roll of pizza dough." The partners are also building deceleration and acceleration lanes from 37 to provide access to piers for fishing and wildlife viewing, a canoe and kayak launch site, and interpretive kiosks. The levee at Pond 1, managed by the California Department of Fish and Game, is also being reconfigured. Badly subsided land will be topped with dredged material.

"We're hoping to start farming salt marsh harvest mice out here," Brubaker adds. Some areas will be planted with marsh vegetation, but managers expect pickleweed and other plants to arrive with the tides. As sediment starts building up the marsh plain, plants and animals should propagate. But Brubaker thinks it will be a few years before both drive-bys and drive-ins will start seeing differences in the landscape.

"We can booger up a place real quickly, but it takes a while to get it back to where it was historically," says Brubaker. That will start in January 2014 with the long-awaited breach. **JE**

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*Cullinan's new setback levee, constructed last winter. Photo courtesy Ducks Unlimited.*

*COVER PHOTO: Living Shorelines Project near San Rafael, by Stephanie Kiriakopolos*

HISTORY

# Unearthing an Older Delta

If any scientific report could be called a page-turner, it would be *Sacramento-San Joaquin Delta Historical Ecology Investigation: Exploring Pattern and Process*, a 408-page document prepared by lead author Alison Whipple, Robin Grossinger, and their San Francisco Estuary Institute and Department of Fish and Game colleagues. Well-written and copiously illustrated, it portrays a pre-1850 Delta rich in physical variability and habitat diversity. Text boxes explore such topics as Native American land management practices, beavers as ecosystem architects, floating islands, and tall tales about voracious mosquitoes. Delta stakeholders have called the document "a truly significant contribution" (Delta Stewardship Council Chair Phil Isenberg) and "a stunning piece of work, incredibly well done" (Valerie Connor of the State and Federal Contractors Water Agency.)

But is it more than an exercise in nostalgia? "You cannot return to the past," says Isenberg. "For the Delta, that would require a level of social engineering far beyond what the Chinese government did with their Three Gorges project—moving over one million people." With all the constraints imposed by changes since the 1850s, what can history offer modern restorationists?

Quite a lot, according to co-author Grossinger: "The report is not a template for restoration planning. It's a tool to understand what kind of habitats and goals might make sense today and in the future. Without that knowledge, we're shooting in the dark."

Contrary to the popular view of the past, the Delta was never a uniform sea of tules. Grossinger was stunned to find so much complexity and diversity in the Delta landscape. In the western reaches, investigators discovered sand mounds, in the southern reaches, offchannel ponds created by

*continued to back page*

PAST TENSE

## Meander Cuts Bedevil Steamers

As reported in the Stockton **Morning Call** newspaper, 1894, after cuts were made in the San Joaquin River to shorten steamer routes.

*[In the late 1800s,] the San Joaquin River...was simply a long collection of curves, and a steamer had to travel about three miles in a round about manner to make one mile toward its destination. This was, of course, annoying and a great waste of time...*

*It was not until the river began to fall that it was noticed there was something wrong. It really seemed as if the bottom was coming toward the top... This was puzzling for awhile, and then it was found that in making their calculations for the cuts the engineers had overlooked the effect on the tide.*

*In the old days, when the river twisted like a snake, the rise and fall of the tide in the bay did not make a difference in the San Joaquin between Stockton and Twenty-one Mile Slough of more than two feet. The reason of this was that the many curves in the stream prevented the water running out as fast as the tide fell. By the time the tide had fallen six feet in the bay the water fell only two feet in the river, and when the tide rose in the bay it caught the flood and the river commenced to rise again. By this natural phenomenon the river was navigable at all hours.*

*"But now things have changed," said Pilot Arthur Robinson yesterday, "and the water runs through those cuts at low tide as it would out of a tin pan. The tide now falls over three feet at Stockton, and at Twenty-one Mile Slough it falls nearly five feet...*

*"All along the river the effect of the cuts can be seen, as land is uncovered at low tide that has never been before. In some places whole acres are mud flats that used to be covered with water at all times.*

*"The result of this has caused steamboat pilots trouble all during the summer... In those cuts there is not more than four feet of water at low tide, which is not enough for large steamers. In many spots there is not more than that at high tide."*

*Meanders in the San Joaquin River, from an 1862 engraving by Hutchings, which appears in the new historical investigation of the Delta. Courtesy SFEI.*

VOLUNTEER WORK

## Japan Buoys Arrive

It's not a question of if, but when. And when it does arrive, volunteers will be there to track it, providing valuable data to scientists about debris originating from the tsunami in Fukushima, Japan, in March 2011. The first wave of debris is already beginning to wash up on Northern California beaches: during a statewide Coastal Cleanup Day organized by the California Coastal Commission on September 15, items sent to sea by the tsunami were found in Santa Cruz County (a buoy) and Mendocino County (buoys and plastic bottles). In early 2013, shepherded by winter storms, a larger volume of debris is expected to reach the Bay Area, says Coastal Commission outreach manager Eben Schwartz. To keep tabs on the material, the commission has begun distributing special data cards that allow beachcombers to record sightings of construction debris, consumer debris with Japanese text, fishing gear, and miscellaneous items. While debris is certain to reach coastal beaches in San Francisco, San Mateo, and Marin counties, it's unlikely much will pass through the Golden Gate, Schwartz says. "We find very few items that are typical of ocean debris in San Francisco Bay," he said. To play a part in the debris-tracking effort, then, better head west. **NS**

## Bird Poll

It's census time for California's shorebirds. On November 15, professional ornithologists and amateur birders hit the beaches and mudflats of San Francisco Bay to count sandpipers, plovers, willets, godwits, curlews, and dowitchers as part of the annual Pacific Flyway Shorebird Survey. Other coastal estuaries and Central Valley locations will be covered through mid-December. PRBO Conservation Science biologist Matt Reiter says training in shorebird identification and enumeration will be provided for volunteers. Data collected from Washington State to Baja California should help clarify population trends of these birds, which can be sensitive indicators of environmental quality. **JE**

**MORE:**
data.prbo.org/apps/pfss/index.php

OBSERVATIONS

# Of Geese and Eelgrass

It's a clear evening on the cusp of autumn, and the eelgrass brigade is walking on water. The surface of San Francisco Bay reflects the miracle like a mirror: Six people in wetsuits are balancing white pvc pipes on their shoulders as they step through the receding tide. They're taking advantage of the evening low tide to study a peculiar meadow of *Zostera marina* that grows alongside Alameda.

Most of the eelgrass that grows in Bay shallows is perennial—it stays alive for two years or more. But the majority of the plants at Crown Beach flower, set seed, and die by December, then sprout afresh from seed every spring. Responsibility for this state of affairs lies at the webbed feet of Canada geese. Graduate student Stephanie Kiriakopolos and Katharyn Boyer, a San Francisco State University professor of ecology, have found that migrating geese mow down so much Crown Beach eelgrass each autumn that few perennial plants survive. "This is the first time an herbivore has been shown to be responsible for the tipping point between a plant population being annual or perennial," Kiriakopolos says.

Native geese aren't the only herbivores that devour eelgrass in San Francisco Bay. An invasive amphipod (a type of marine crustacean resembling a sowbug) from the East Coast, *Ampithoe valida*, may also be hurting local eelgrass acreage. "The amphipods actually eat the *Zostera*. But they don't eat eelgrass in their native range, only macroalgae that grows alone or on eelgrass. We want to understand why they act differently here than in their native range," Boyer says.

To find out, Boyer and Kiriakopolos are setting up a series of experimental plots just offshore.

Some plots will exclude geese; others, both geese and amphipods; while control plots will remain completely open.

This work is part of a global project examining the factors that affect eelgrass growth. Because this species is so important to shoreline habitats, the Zostera Experimental Network involves 15 other sites ranging from Japan to Finland to British Columbia.

On this evening, the researchers head out in pairs to erect the plots. One person kneels down in the shallow wavelets, placing a triangular template on the bay floor. The other pushes a pipe into the packed sand at each vertex to form the corners of the plot.

Working in the pool of light from her headlamp, Kiriakopolos gathers green ribbons of eelgrass inside the plot before securing lengths of plastic fencing around the pipes. The plots will remain up for two months, giving grazers an ample window to do their damage. A breeze plays over the open tops of the plot pipes, emitting a soft howl as an orange crescent moon rises overhead. **KW**

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Photo: Stephanie Kiriakopolos

# Four Decades of Bay Discoveries

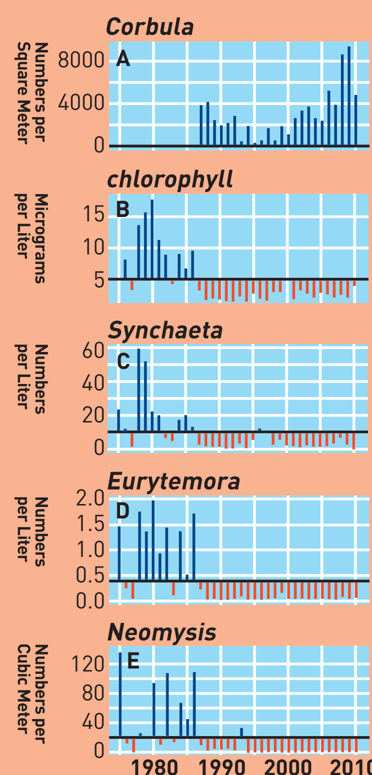
A federal top dog once asked Jim Cloern just how long he needed to study San Francisco Bay before he "figured it out." Thirty years seemed plenty long enough to the guy asking the question. But Cloern's answer, both then and now a decade later, is the same: "When it stops changing."

San Francisco Bay's monitoring records of both biological communities and environmental conditions are among the longest-running and most comprehensive assembled for any estuary in the world, thanks in part to scientists like the U.S. Geological Survey's Cloern, who've fought year-in-year-out to keep the boats out on the water, and the gages and gizmos running, that measure everything from salinity to plankton growth to how cloudy the water is and how much runoff from the Sierras reaches the sea. And every time Cloern is sure he's figured it out, something changes. The changes he thought he'd pretty much figured out were the ones caused by humans – the dams, the diversions, the invasions... But the big surprise came in 1999, and it had nothing to do with any of these activities.

"I'm not sure there's another bay or estuary around the world where there is as clean a signal, or a signal as well supported by data, showing how biological communities became transformed in a short period time, a couple years, by a major climate shift," says Cloern. "These are the kinds of processes, these natural cycles in the climate system with periods of 20-40 years, that you can only understand if you've been measuring for a period of time that's as long, or longer, than the period of the process."

After 37 years of study Cloern has figured a few things out. In an eloquent new paper published this October in *Reviews of Geophysics*, he and veteran UC Davis estuarine scientist Alan Jassby summarize how environmental conditions in the estuary have changed since the 1950s, and highlight the six driving forces behind this change. These "drivers" are familiar players in California's water wars and ecosystem management endeavors – human consumption and diversion of the estuary's fresh water, modification of its sediment supply and introduction of non-native species, as well as the ongoing use of the Bay for sewage disposal. Less obvious, perhaps, have been two other drivers of change: environmental policy on both federal and local levels, ranging from the Clean Water Act to the state's curbs on ballast water discharges and "X2" standard, which protects the estuary's low-salinity habitats; and climate shifts associated with major rearrangements of ocean currents and temperatures beyond the Golden Gate.

**ALIEN CLAMS REINVENT FOOD WEB**




*Response of the planktonic food web in Suisun Bay to the introduced clam,* Corbula amurensis. *(A)* Corbula *abundance. (B) Phytoplankton biomass as* chlorophyll a *concentration. (C) Density of the rotifer* Synchaeta bicornis. *(D) Density of the copepod* Eurytemora affinis. *(E) Density of the mysid shrimp* Neomysis mercedis. *The horizontal line in Figures 11b–11e is the long-term mean. Source: Cloern & Jassby, 2012*

"The estuary never ceases to change, but not just in a so-called stationary way, which is a statistical term meaning with some fixed mean and variance, but every now and then it becomes almost a new system in terms of ecosystem functioning," says Jassby.

The paper describes shifts in the timing and extent of freshwater inflow and the intrusion of salt water further upstream into the estuary. It details the gradual decrease in turbidity, as more sediment eroded from the watershed remains trapped behind dams, and as the vast amount unleashed by hydraulic gold mining in the prior century finally washes through. It talks about the restructuring of plankton communities, and resulting loss of food supply for endangered pelagic fish, as a result of the invasion of Suisun Bay by an alien clam. And it delves into the region's water quality history, among other topics.

"Today's bay system is a very different from the one that existed in 1976 when I started studying it," says Cloern. "The shoreline is different, because of changes like salt pond restoration work. The shape of the bay floor is different — the bay is losing sediments and getting deeper. The sediment supply to the estuary is half what it was in 1950s. Some biological communities in Suisun Bay are unrecognizable from those that existed 30 years ago. And although we haven't seen as many changes in which species are present in the South Bay, the relative abundances of common species now are distinctly different from those prior to 1999. At the same time, major water-quality problems like hypoxia below the Dumbarton Bridge, or high metal concentrations in sediments and organisms, which plagued the South Bay in the 1960s and 70s, are now largely gone. So there are good news stories and bad news stories, but collectively they depict a bay that is very different from the bay of 1876 or even 1976."

What factors drove the estuary to change so much in such a short time period? A brief survey of the paper's findings follows, but this reviewer recommends taking a few hours to read the paper itself. There are few places in the gigabytes of research about the San Francisco estuary where so much is said so well in so few pages — even if there is the occasional daunting equation.

*continued to page 6*

**MONITORING**, *continued from page 5*

One of the far-reaching alterations to the estuary is the capture and diversion of fresh water before it flows into San Francisco Bay — driver #1 discussed in the paper. Not only is less freshwater flowing through the estuary today — about two thirds of unimpaired flows — but it's also flowing through later than it did naturally, in the dry rather than wet part of the year.

In response to freshwater exports, the estuary's salinity gradient has shifted landward (upstream), and salty water now intrudes farther into the Delta in certain months than it did historically, especially during autumn when it's dry. The authors note how these changes within estuarine waters have contributed to the disruption of the biological communities living in them, to the extent that the populations of many native species, from the tiniest plankton to larger fish, are on the wane.

The discussion of driver #2 revolves around sediment. Ever since the Gold Rush, human activities ranging from hydraulic gold mining to the construction of dams and dikes have changed the estuary's sediment supply. The supply has halved since the mid-19th century, when an ocean of mud from mining in the Sierra foothills washed downstream. Indeed, comparisons of bathymetric charts confirm that from 1856 to 1887 some regions of San Pablo Bay accumulated more than four meters of sediment, and intertidal mudflats expanded by 60 percent. The sediment supply peaked at about 12 million metric tons per year in late 19th century, then declined to less than one million metric tons per year today, the authors note.

With a 50 percent drop in suspended sediment concentrations, light penetration into the water has almost doubled in some locations, the authors write. With more sunlight, algae growth rates are probably higher than in the past, raising the spectre of blooms that steal the oxygen from the water and suffocate fish, but also the potential for a stronger food supply for estuarine communities. Water clarity also affects predator-prey relationships and can change habitat quality for native fish species. An index of habitat suitability for delta smelt, for example, declined 78 percent between 1967 and 2008 as a response to trends in increasing water clarity and salinity.

Another challenge to the health of native fishes and the ecosystem is driver #3, introduced species. As international commerce has trans-located microbes, plants and animals across the planet, they've become a powerful component of ecological change.

Photo: Cary Burns Lopez

*The diatom* Thalassiosira rotula *was the number 1 ranked species contributing to phytoplankton biomass in San Francisco Bay until the 1999 climate shift. After 1999 the number 1 ranked species has been another diatom,* Thalassiosira punctigera, *which was never seen in the Bay until then.*

The authors describe one local example. In 1986, scientists speculate that a ship brought the larvae of a clam with Asian origins to San Francisco Bay in its ballast water. By 1988, *Corbula amurensis*, (sometimes called the "overbite clam" for its larger top shell), dominated the benthic community in Suisun Bay, reaching abundances as high as 16,000 individuals per square meter. It colonized a vacant niche, and flourished because it could handle variable salinities and use a broad range of food resources. Indeed it is so efficient at filtering food out of the water column that its annual mean filtration rate of Suisun Bay is about twice the growth rate of the phytoplankton it's eating. *Corbula* has reduced phytoplankton biomass and primary production in Suisun Bay fivefold, limiting what herbivorous zooplankton have left to eat.

Added on top of other stresses on the food web caused by altered freshwater inflows and intruding salt water (the two previous drivers described), an alarming trend emerges. The authors detail an unprecedented restructuring of the Suisun Bay zooplankton community since the 1970s, from one having large components of mysid shrimp, rotifiers, and calanoid copepods to one dominated by East Asian cyclopoid copepods (see chart, p.5). Losses of these native zooplankton helped lead to losses of the native fish that eat them, as the fish searched for food elsewhere, in less suitable habitats, or settled for eating less nourishing aliens. These ecosystem disruptions by invaders have been so well documented here in San Francisco Bay that they helped motivate passage of some of the country's toughest ballast water treatment regulations.

Tough clean water regulations helped rid South San Francisco Bay of the worst of the environmental effects of driver #4: sewage inputs. Sewage contains an array of pollutants, including nutrients (nitrogen and phosphorus), organic matter, toxic metals, pharmaceuticals, and pathogens that pose risks to human and ecosystem health. To get a sense of the scale, the South Bay alone receives 500,000 cubic meters of municipal wastewater annually from about 12 treatment plants serving four million people. Treatment removes many pollutants, but nutrients remain a pressing current concern.

The authors report that sewage discharges deliver 11,200 tons of nitrogen and 1,860 tons of phosphorus in dissolved inorganic forms (called "DIN and DIP") to the South Bay annually. Indeed South Bay nutrient levels are 7-10 times those measured in more rural bays along the West Coast, according to the paper. Based on these high N and P concentrations, the South Bay has the potential to produce phytoplankton biomass at levels that severely impair other nutrient-enriched estuaries like Chesapeake Bay on the coast of Maryland and Virginia.

Until recently, South San Francisco Bay's strong tidal currents, turbidity, and hungry clam population have saved it from algae blooms and other ecological problems triggered by an excess of nutrients in the water, but "this resistance is weakening," write the authors.

"The amount of phytoplankton in the South Bay is now three times higher during the dry season than it was ten years ago," says Cloern. "The question now is what trajectory will this follow in 5, 10, 15 years, and will we ever reach some tipping point where nutrients are converted more efficiently into living phytoplankton biomass, and start generating the classic water quality problems seen in Chesapeake Bay."

*continued to page 11*

MANAGEMENT

# Duck Ponds Run Afoul

There's too much mercury and too little oxygen in some of the drainage from Suisun Marsh duck ponds, leaving public and private land managers experimenting with alternate management practices. Suisun Marsh has been a magnet for duck hunters since the 1850s and through the decades duck clubs have kept key parcels preserved from development and also provided habitat for non-game wildlife and migratory waterbirds. The drainage problem occurs in the fall, when water used to flood managed seasonal wetlands is discharged into neighboring sloughs.

According to Steve Chappell of the Suisun Resource Conservation District, at this time of year, warm temperatures cause rapid decomposition of vegetation in ponds, while anemic tides fail to exchange resulting low oxygen water from the ponds with more oxygenated water from the Bay. Under these conditions, "Some of the discharges into small dead-end sloughs depress dissolved oxygen in the system," he says. The phenomenon mainly occurs in Peytonia, Boynton, and Goodyear Sloughs, tributaries to Suisun Slough, he says.

The water returning to the marsh's sloughs may not only be low in dissolved oxygen (DO), but also high in methylmercury, a chemical cousin of the Gold Rush era quicksilver lurking in the mud. Methylmercury, formed when anaerobic bacteria in wetlands gets to work on legacy mercury, is a neurotoxin that bioaccumulates in food webs. Methylmercury can be harmful to fishing birds, humans and other apex predators.

Low DO events, according to a 2011 report by Stuart Seigel of Wetlands and Water Resources and other scientists, "eliminate the fishes and invertebrates in the sloughs affected." It may take months before "desirable" fish—native species and popular introduced game fish like striped bass—move back in. Fish and other organisms that can tolerate low DO are mostly exotics: carp, catfish, Black Sea jellyfish.

Fish kills ascribed to low DO were first documented in 1999 and have recurred through 2009. UC Davis biologist Teejay Orear says that although there were low-oxygen events in Peytonia and Goodyear last year, the decline was slow enough to allow most fish to escape from the affected areas.

"We've focused on working with landowners to modify management practices," says Chappell. The 2011 report reviewed 19 potential best management practices (BMPs), 14 for water operations and five for soil and vegetation management, and recommended further study and case-by-case evaluation. Future actions may include field tests of selected BMPs and a review of the DO standards for Suisun.

One option is to coordinate drainage operations so multiple clubs don't introduce low-oxygen water to the sloughs at the same time, or to delay flooding when tidal mixing is low and temperatures are high. Another is shifting from green and leafy vegetation like cocklebur and fat hen to grasses, including timothy and bulrushes. The District's three water managers have been working with club managers. "Some landowners are reluctant to have government scientists on their land," Chappell adds. "We try to reinforce with them that improved BMPs are in everyone's interest—good for the marsh and the wildlife." **JE**

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SPECIES SPOT

## Wanted: Otter Spotters

North American river otters have charisma to burn. Biologists know relatively little about their lifestyles, distribution, and population trends in the Bay Area, though. Megan Isadore and Paola Bouley, co-founders of the River Otter Ecology Project, hope to change that with the aid of "Otter Spotters" who report their sightings to the nonprofit's web site, where they're posted on an interactive map.

"In Marin County, people report seeing otters more and more often," Isadore says. Since the aquatic mammals are sensitive to pollution, that could be good news for the health of local streams. But there is little baseline data about otter history in the Bay Area. Clearly, historic fur trapping reduced their numbers. None were seen in Marin from the 60s into the 80s, when naturalist Rich Stallcup discovered a population on Walker Creek near Tomales Bay.

Although the web site has only been up since February, sightings have come in from as far north as the Lost Coast and as far inland as the Mokelumne River in the Sierra foothills. Several have been observed in the Bay, off Sausalito, Richmond, and Alameda. "They definitely use salt water, almost as much as fresh," says Isadore. Otters have visited lakes in several East Bay Regional Parks and dropped by the beaver pond on Alhambra Creek in Martinez. Beyond spotter reports, Isadore and Bouley use remote cameras to record behavior and analyze otter scat ("spraints" to the British) to document seasonal prey preferences. They want reports of dead as well as living otters to help map casualties at street crossings so habitat corridors can be protected.

The River Otter Ecology Project recently obtained tax-exempt status. The program has been funded by grants and donations, including one from the Rose Foundation. Isadore expects to begin publishing results in late 2013.

Why otters? "River otters are highly dependent upon clean water with plenty of fish," says Bouley. "The same conditions that make for healthy 'ottersheds' make for healthy human habitat. Their return so close to large cities illustrates just how adaptable and resilient wildlife can be." **JE**

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Web: www.riverotterecology.org

Photo: Paola Bouley

# SNAPSHOTS OF BAY-DELTA SCIENCE

Just over a thousand scientists, policymakers, and others packed the Sacramento Convention Center in mid-October for the 7th Biennial Bay-Delta Science Conference (formerly the CALFED Science Conference.) The three-day event, with the theme of "Ecosystem Reconciliation: Realities Facing the San Francisco Estuary," featured 240 speakers, 150 poster exhibits, and the presentation of the Brown-Nichols Science Award to Wim Kimmerer (San Francisco State University Romberg Tiburon Center) and Jim Cloern (U.S. Geological Survey). Here are a few stories that emerged from the presentations.

## SUBMERGED SURPRISE

Scanning GoogleEarth images of Suisun Bay a couple of years ago, California Department of Water Resources engineer Chris Enright spotted something unexpected: large beds of submerged aquatic vegetation along islands and on offshore shoals. Katharyn Boyer of SFSU's Romberg Tiburon Center identified the plants as native pondweeds, *Stuckenia filiformis* and *S. pectinata*. "They've probably been present for a long time, just not noticed," said Boyer at the conference, referencing an 1886 map and a 1937 aerial photo. Her survey verified at least 1,100 acres covered by *Stuckenia* and indicated the beds are expanding within Suisun Bay and the West Delta. "Native submerged aquatic vegetation is a very turbid environment and may be a positive benefit for native fish," she added. In a conference poster with Evyan Borgnis, Boyer also projected that *S. filiformis* may outcompete the exotic Egeria densa as the West Delta becomes saltier. **JE**

## BIOSENTINEL SPARROWS

The canary in the coal mine has a new colleague: the song sparrow, recently chosen as a biosentinel species for methylmercury contamination in the Bay Area's riparian food webs. At the conference, April Robinson of the San Francisco Estuary Institute explained that this common native songbird offered several advantages. It's not only a year-round resident in riparian areas and has a small home range, but it is also widespread and abundant, easy to capture, and sensitive to mercury. The song sparrow feeds primarily on insects and other arthropods during its breeding season and bioaccumulates methylmercury that its prey acquires from streamwater. Robinson said its diet includes insect-eating spiders and the emergent forms of insects that have an aquatic stage. Preliminary data shows a range of 0.01 to 2.7 parts per million in local sparrows, with highest concentrations along the Upper Guadalupe River. "These are very urban sites where populations are already impacted by non-native predator, habitat loss, and human disturbance," she explained. The upper levels have been associated with a 25 percent reduction in breeding success in an eastern songbird, the Carolina wren. **JE**

## THE TWO FACES OF SMELT

Two conference presentations looked at the endangered delta smelt in a food web context, as predator and prey. What the smelt are eating, according to Aaron Johnson of San Francisco State University's Romberg Tiburon Center, came as a surprise. Thought to rely mainly on the small crustaceans called calanoid copepods, the adult smelt sampled by Johnson at a Sacramento River site favored amphipods, which accounted for two-thirds of their diet by weight. Most of the amphipods were benthic species. "If it's a shift, is it short-term or a function of larger food web changes?" he asked. It could reflect the decline of mysids, another class of smelt prey. Johnson's study was the first to examine smelt feeding habits over hourly and tidal time frames. Meanwhile, what's eating the smelt? UC Davis graduate student Scott Brandl is using mitochondrial DNA barcoding to identify smelt remains in the guts of predatory fish. So far, 69 of a sample of 559 exotic Mississippi silversides have tested positive for smelt. Predation appears less common in turbid waters. This winter, the project will be extended to striped, largemouth, and smallmouth bass and Sacramento pikeminnow to compare predation on smelt by native and non-native fish. **JE**

## CHAIN OF HABITATS

UC Davis fish biologists call it the North Delta Arc: a chain of aquatic habitats from Suisun Marsh to the Sacramento Deep Water Ship Channel. It seems to be a kind of "Noah's Ark" as well, where native fish species still outnumber invasives. At the conference, John Durand pointed out that the area is also on everyone's radar as a site for habitat restoration under the Bay-Delta Conservation Plan. Denise De Carion said fish abundance and species richness were especially high in Cache and Lindsey Sloughs and the Deep Water Ship Channel, where more than half the species recorded were natives. Non-native nearshore fish, booming elsewhere in the Delta, accounted for small percentages at these sites. "Something is allowing natives to persist in the presence of non-natives," she concluded. The Davis team plans to look at fine-scale habitat characteristics and trophic interactions for clues that might guide restoration efforts. James Hobbs has been using the chemical composition of delta smelt otoliths (ear bones) to reconstruct their migration history. He reported that some smelt are permanent residents in the Arc's fresh waters despite warm summer temperatures. That's the good news. The bad, relayed by Peter Moyle, is that some of the Arc's native species are at risk of extinction. Moyle calculated separate scores for baseline vulnerability to extinction and vulnerability with projected climate change. "Fish have low adaptive capacity to move around," said Moyle. "Fish can't fly north. A lot of the natives are highly vulnerable to climate change, but many non-natives will do just fine because they're already well adapted to human-created environments." Delta smelt (critically vulnerable with a high probability of extinction) and common carp (indestructible) represent the extremes. In between, some natives should respond to careful management: "One of the places where positive action is possible is the North Delta Arc." **JE**

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CONFERENCE

# Speaking Different Languages

Conducting science in the Delta, at the confluence of the livelihoods of millions of human and non-human Californians, has always been a challenge. While the region is still a dimly-lit terra incognita in the mental map of many Californians, in terms of water politics it is under such an intense spotlight that research here has to withstand as much heat as light. When a scientist publishes a study with narrow and carefully considered conclusions on, say, stressors affecting a species, the interpretation of those results may take on a political life of their own, often beyond the control of the investigator. On the other hand, scientists who wish to conduct more broadly designed research aimed at informing policy say this work is sometimes ignored.

At the recent Bay-Delta Science Conference, Peter Goodwin, the Lead Scientist for the Delta Stewardship Council, organized a "town hall" meeting to brainstorm solutions to these long-standing issues. At the packed lunchtime session, policymakers were seated in a panel at the front of the room, and scientists had an open mike in the audience. Both friendly suggestions and pointed barbs flew.

Panelist Randy Fiorini, a Turlock farmer and board member of the Delta Stewardship Council, said he was looking for a "master model" for the Delta instead of the many disconnected models now being used to analyze ecosystem and water supply functions. Fiorini said it was essential to fund monitoring of projects and experiments so their impact could be assessed. He also said he was looking for more collaboration in framing scientific research: "I propose we try a new model that involves policymakers from the start."

Like Fiorini, Director of the Department of Water Resources Mark Cowin asked for more clarity from scientists. "Policymakers need a better understanding of what we know and don't know — and what the level of uncertainty is — as we incorporate information into the economy versus environment decisions," he said.

Scientists came up to the microphone to push back, with one saying it was his job "to investigate uncertainty, not define it." Christina Swanson from the Natural Resources Defense Council commented, "You will rarely get a scientist to say 'this is what you should do.' They don't think that's what their job is. Science is an emergent process. It is never done." She said there was a need for "a translator or interface" and that non-governmental organizations like hers were one kind of interpreter.

Jim Cloern, a senior ecologist with the U.S. Geological Survey, was ready to try a new approach. "There's a real breakdown in the system. We need to revolutionize the way scientists and policymakers communicate," he said. Later, Cloern explained that he thinks scientists and policymakers should be collaborating early in the conceptualization of research, so that results are more useful in shaping eventual action in the Delta. While the independence of the conclusions of scientists must be protected, the design of the research could benefit from early feedback, he said. "The reason why our science isn't being used is [that scientists and policymakers] live in different worlds. We need to join the same universe."

Panelist Ren Lohoefener, Pacific Southwest Regional Director of the U.S. Fish and Wildlife Service agreed. "If we can't find a way to be open and transparent and collaborative, we're not going to succeed."

After the conference, Goodwin said he was pleased with the town hall and ensuing hallway conversations. After reviewing audience surveys, he said many participants agreed on the need for "doing something bold" to improve the science-policy interface. "People were saying, let's try and do some large action in the Delta where we can really create a change" of sufficient scope to provide meaningful results. Early communication between scientists and policymakers and well-funded monitoring would need to be part of the project. "The most important idea was, if we really want to change the way we do things, we need to create a single science vision and a science plan that everyone can participate in and contribute to… [We need] the ability to look across larger spatial scales and at whole system functions, and not just at the corner we're responsible for." **SKM**

FRONT ROW

## A Milestone Breach

A cheer went up on October 31st as one more levee was breached at the South Bay Salt Pond Restoration Project. As a crowd of 100 applauded, a backhoe bit into a half-century old dike in Alviso to let Bay water pour from Coyote Creek into Pond A17 at the Don Edwards San Francisco Bay National Wildlife Refuge. Poked through on the 40th anniversary of the Refuge, the breach represents an important milestone for the restoration project, bringing the total number of acres in active restoration to 3,200 out of 15,100 eventually planned. Pond A17 is paired with its neighbor to the south, Pond A16, to meet the needs of creatures with different habitat needs. For the clapper rail and salt marsh harvest mouse, A17 will be allowed to revegetate naturally into marsh. By contrast, for shorebirds such as American avocets, black-necked stilts, and western snowy plovers, A16 will be carefully managed as a shallow, largely plant-free pond with sixteen constructed islands for nesting. A water gate will be carefully calibrated to let just enough water flow from A17 into A16 to maintain a water depth of 6 to 12 inches in one large section of the pond to meet the needs of the shorebirds who prefer shallow open water to marshes. **SKM**

*Photo: Susan K. Moffat*

POLLUTION

# A Cautionary Tale about Caulk

Everyone's seen buildings shrouded in black netting or white plastic, and heard the hum of industrial strength vacuums hoovering up chips of lead-laden paint and other toxic substances shed by remodeling and construction. The purpose of all this effort is to keep such substances out of the air and urban runoff into the Bay. The S.F. Estuary Partnership recently put the wraps on a three-year-project that might add one more substance to these cautionary scrap piles: caulk.

Photo: Ariel Okamoto

Not just any caulk: only caulk used between the 1950s and 1980s to seal up joints and seams between walls, windows, and bricks, and most often employed in concrete and masonry buildings. This was the period when builders mixed PCBs —polychlorinated biphenyls now banned because they are suspected human carcinogens — into some caulks to increase flexibility.

The project team started with a focus on building exteriors. "We were looking for materials that had a nexus to the outdoors, where there might be a connection to urban runoff," says the Partnership's project manager Athena Honore. The team was also interested in building demolition, because it offered a logical opportunity to capture PCB-containing materials before they entered the surrounding watershed.

As a first step, the Partnership asked the S.F. Estuary Institute to determine to whether any Bay Area buildings might contain caulk with PCB-levels as bad as those that raised red flags in East Coast buildings. In a report released in November 2011, the Institute, a project partner, confirmed the prevalence of PCBs in standing Bay Area buildings constructed during the period of PCB usage. They detected PCBs in 88 percent of 25 caulk samples collected from exteriors of ten buildings. Of these, 40 percent exceeded concentrations of 50 parts per million (the concentration where EPA remediation regulations kick in). The highest concentration found was 220,000 ppm.

The Institute also developed a rough estimate of the mass of contaminated caulk contained in buildings in their study area (four counties and three cities with large sectors developed during the PCB usage period). Using GIS models, historic imagery, and land use data, they computed a mid-level estimate of a total mass of 10,500 kilograms of PCBs in caulk in these buildings, or an average of 4.7 kg per building. If all the PCB-containing caulk from just one such building got loose during demolition and washed into the Bay, the amount would be more than twice that allowed by water quality regulators for urban runoff from the entire Bay Area.

The news is not all bad. Builders and demo crews can prevent PCB runoff by taking steps already prevalent in the construction trade today. Such "best management practices" include carefully removing contaminated caulk, attaching vacuums to tools used for grinding concrete or masonry substrate formerly in contact with caulk, and collecting dust and debris on plastic drop cloths. To carry out such tasks, workers should also wear masks and protective clothing.

"The PCBs in caulk problem is just starting to hit the building and demolition industry's radar," says Honore.

The second wave of the Partnership's project involved developing a regional model for how municipalities could tackle the problem, adding a step for PCB screening, and if necessary removal, to the demolition and remodeling permits administered by municipal planning or building departments. Under this model, PCB screening would apply to multi-story buildings (generally commercial and industrial), but not to single-family homes (PCB containing caulk is unlikely to have been used in such homes).

Filling in the details, consultants including Larry Walker Associates, Geosyntec, and TDC Environmental created various screening and assessment tools to identify PCB contaminated buildings, outlined clean up and runoff prevention plan steps for builders, and laid out a clear process for cities and counties to work with EPA on certification and approval.

"It looks like caulk in our older buildings could be contributing to PCBs in urban runoff, and, importantly, this source of PCBs is controllable," says Jan O'Hara of the S.F. Bay Regional Water Quality Control Board.

The model ordinance would offer another tool for helping cities reduce the PCBs that are discharged to their storm drain systems and eventually flow untreated to the Bay. The Bay Area's municipal regional stormwater permit, issued in 2009 by the regional board, required permittees to investigate a variety of PCB control measures. Once investigations are complete, all these measures and tools will be considered when requirements for the next permit term, beginning in 2014, are proposed. **ARO**

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## PCBS IN CAULK FINDINGS

| | |
|---|---|
| Samples analyzed for PCBs | 25 |
| Number of buildings sampled | 10 |
| Samples in which PCBs detected | 88% (detection limit:≥25 parts per million, or ppm) |
| Range of PCB concentrations in caulk | 1-220,000 ppm — 20% of samples >10,000ppm |

*Source: [1] Klosterhaus, S., Yee D., Kass, J., Wong, A., McKee L. 2011.* PCBs in Caulk Project: Estimated Stock in Currently Standing Buildings in a San Francisco Bay Study Area and Releases to Stormwater During Renovation and Demolition. *SFEI Contribution 651. San Francisco Estuary Institute, Oakland, CA. 49 pp.*

**MONITORING**, *continued from page 6*

While human activities have deeply undercut the integrity of our estuarine ecosystem, they've also helped protect it with strong environmental policies — driver #5 — such as the 1972 Clean Water Act. Before the act, rivers like Cleveland's Cuyahoga were so polluted they caught fire, and in San Francisco Bay, fish kills were common and toxic metal levels in clams among the highest in the world. The authors reviewed data from sampling programs before and after the Act to show how these policies helped the Bay recover from sewage-derived pollutants, among other challenges. Monthly sampling of clams once so impacted by the copper and silver in Bay waters they could not reproduce, for example, showed a distinct recovery after local sewage plants began using more advanced treatment processes mandated by Congress. Today, however, the standards set by the Clean Water Act "have not been fully met," write the authors. A 2004 assessment of 141 estuaries in the United States determined that the majority still have moderate to high symptoms of excessive nutrient effects, for example.

The last driver Cloern and Jassby discuss operates on a much larger scale than our human engineered dams, invasions, discharges and other effects: the ocean-atmosphere system. While fishermen have long noted how some species favor warm or cool periods out in the ocean, scientists are only recently figuring out just how strongly changes in ocean and climate conditions out in the Pacific affect the species that live in San Francisco Bay. And the reason it took them so long to figure it out is that these changes only occur every 20-40 years.

"There's always going to be surprises, things we can't forecast that happen at time scales longer than our monitoring record," says Jassby.

The authors explore the major "regime shift" that occurred in the late 1990s when atmospheric pressure, wind patterns, ocean temperatures and biological productivity (upwelling of nutrients and plankton growth) all changed in the Pacific offshore. Surface waters cooled and upwelling increased. As the Northeast Pacific shifted from a warm phase to a cool phase, the biological communities in the Bay shifted too (see charts). The authors suggest that variability in coastal oceans can be just as powerful a driver of change inside estuaries as human activities and watershed processes on land and upstream.

One refreshing part of this paper is how the authors are able to compare San Francisco Bay to conditions in estuaries worldwide – most of which are as bedeviled by water diversions, sediment shifts, contaminants, invaders, and climate variability as ours. These types of comparisons would not be possible without long term data from research and monitoring programs here in our estuary (such as those championed by IEP, USGS and SFEI), and without the commitment of experienced scientists like Cloern and Jassby to analyze them.

"When you come across a data set, and it's got some critical years missing, it can be exasperating," says Jassby. "Look at some of the older records, like the cherry tree flowering records in Kyoto, which go back to the 9th century. These records, which can be used as a surrogate for spring temperature, have revealed all kinds of interesting solar-cycle-related and other variations that are of interest to climate scientists. This is an inspiration for the time scale we've really got to think about for San Francisco Bay — long term, indefinite, generations down the line." **ARO**

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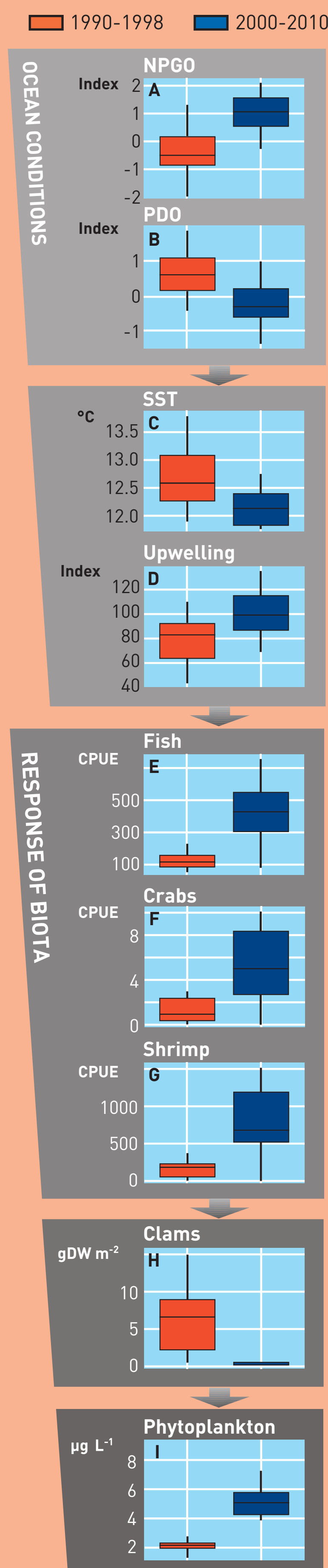
**PAPER**: http://www.agu.org/journals/rg/rg1204/2012RG000397/2012RG000397.pdf

Cloern, J. E., and A. D. Jassby (2012), Drivers of change in estuarine-coastal ecosystems: Discoveries from four decades of study in San Francisco Bay, *Reviews of Geophysics*, 50, RG4001, doi:10.1029/2012RG000397

## OCEAN COOL DOWN TRIGGERS TROPHIC CASCADE




*Time series of annual mean climate indices, ocean conditions near the mouth of San Francisco Bay, and annual mean abundances of various biota within San Francisco Bay, shown as anomalies about the long-term means. (A) North Pacific Gyre Oscillation and (B) Pacific Decadal Oscillation (ocean-atmosphere changes). (C) Sea surface temperature at Farallon Islands. (D) Upwelling index. Sum of catches per unit effort (or "CPUE") in South, Central, and San Pablo bays for (E) five species of demersal fish, (F) three species of crabs, and (G) two species of shrimp. (H) Dry weight of clams from South Bay sampling sites. (I) Annual mean phytoplankton biomass (*chlorophyll a*) in South Bay surface waters. Source: Cloern & Jassby, 2012*

SAN FRANCISCO ESTUARY PARTNERSHIP

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San Francisco Bay and the Sacramento-San Joaquin River Delta comprise one of 28 "estuaries of national significance" recognized in the federal Clean Water Act. The San Francisco Estuary Partnership, a National Estuary Program, is partially funded by annual appropriations from Congress. The Partnership's mandate is to protect, restore, and enhance water quality and habitat in the Estuary. To accomplish this, the Partnership brings together resource agencies, non-profits, citizens, and scientists committed to the long-term health and preservation of this invaluable public resource. Our staff manages or oversees more than 50 projects ranging from supporting research into key water quality concerns to managing initiatives that prevent pollution, restore wetlands, or protect against the changes anticipated from climate change in our region. We have published *Estuary News* since 1993.

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**READERS:** You'll notice this last issue comes late — we decided on an October-November combo to make room for some late breaking news. At the New Year, look out for an entire issue dedicated to climate change science and planning progress in the Bay Area, including the thorny question of sediment supply to combat sea level rise.

**HISTORY**, *continued from page 3*

woodjams, in the northern areas, giant riparian forests and perennial lakes.

Grossinger thinks functional mosaics of habitat could be reestablished today, in a few key spots. "They may not be in the same places where habitat was in the past," he says," pointing out that future flow regimes should be considered in terms of how they would support restoration. "We didn't study how much water came into the Delta but what it did there, how it made different kinds of habitat."

"The large marshland is all gone," says Carl Wilcox of the Department of Fish and Game. "The only way to get it back is to go where it isn't subsided: the edge of the Delta." Pilot projects on filling in subsided islands using biological methods look promising, he adds. "We have to be looking for places with the potential to keep up with sea level rise as well as giving restored habitat some place to go. You can't just restore it and build a levee around it. You need to connect it with the uplands so it can move, accommodating marsh transgression."

Wilcox says the report will help planners avoid costly mistakes: "The point is to not try to force a desirable habitat component into a place it shouldn't be." For example, he says historic Delta channels look different from Bay channels, with lower density and fewer dendritic patterns: "If you try to create a bunch of fingerlike channels without enough tidal plain around them, you can end up with backwaters that are nice places for non-native species."

Connor, whose organization represents, among others, the Westlands Water District and the Metropolitan Water District of Southern California, says the idea of reestablishing historic functions in new places really resonates with her. SFCWA is using this information to look at specific restoration projects in terms of what was there and what can be brought back. "We have so many acres to do, all in an adaptive management context. The more information we have, the better the outcome."

For Isenberg, the report is an unusual intellectual product: "Americans have a short attention span as a society and are disdainful of history. This blend of physical science and social science will make many uncomfortable, because it emphasizes the fundamental geophysical facts that shaped the Delta, giving us opportunities but also limiting those opportunities."

The report was designed as a supporting document for the Bay-Delta Conservation Plan and other efforts, notes Grossinger. "Right now the planning for BDCP is at a pretty conceptual scale," adds Wilcox. "Having this report helps put some meat on the bones of what you'd be restoring to." A second project, due in two years, will interpret how native fish and wildlife species used the historic habitat and how those functions might be redesigned into the future Delta.

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