San Francisco Estuary Partnership

Salinity Influences Copper Effects on Salmon

Mercury in the Fog

Beyond the Bird Goo

Canvasbacks Retake Cullinan

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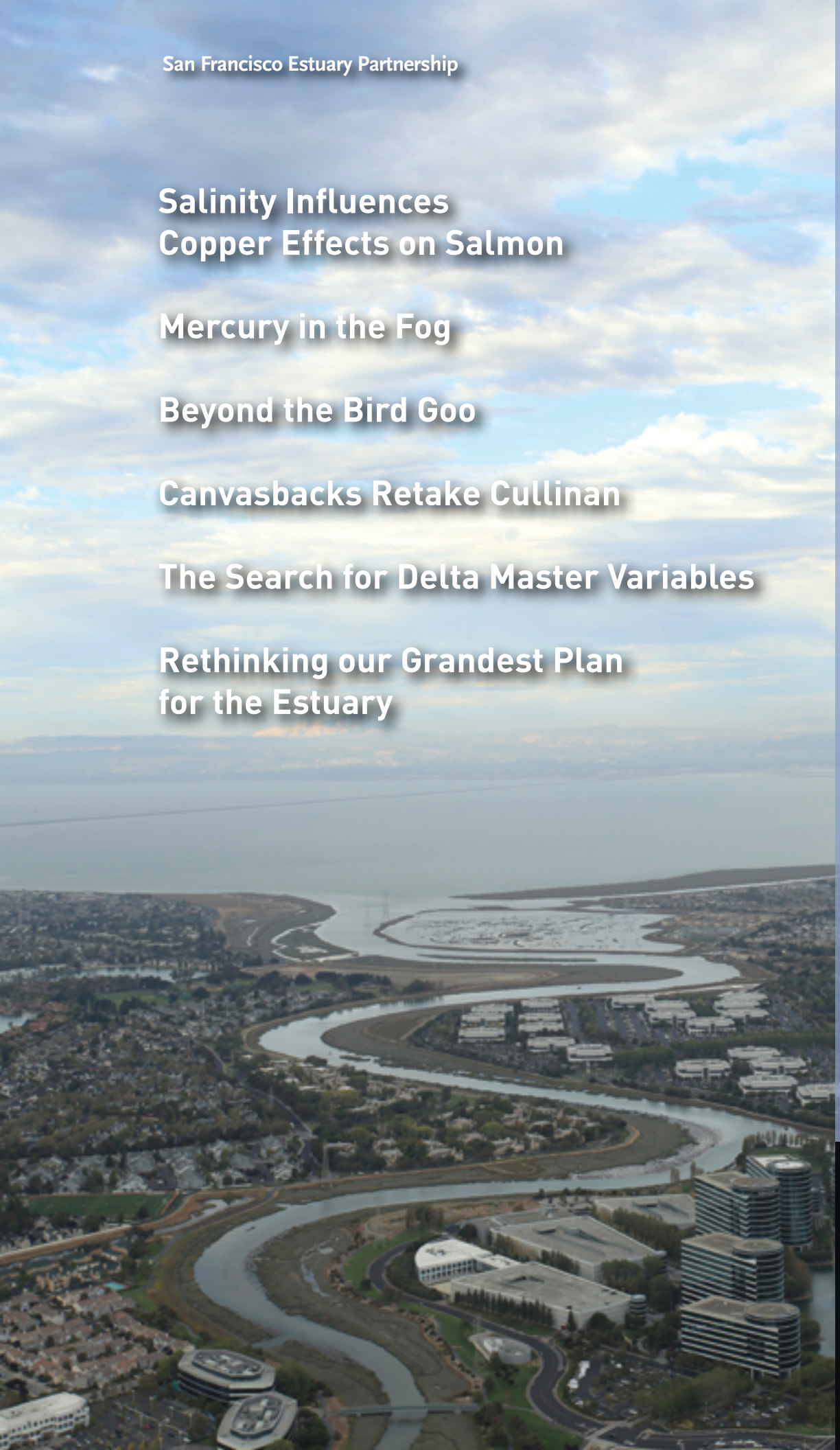
Rethinking our Grandest Plan for the Estuary



SCIENCE • RESTORATION • WATERSHED • POLITICS • SPECIES • BAY

ESTUARY NEWS

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ATMOSPHERE

The Silver Dagger in Fog

The tickle of Pacific fog on skin feels fresh and healthy. But recent studies suggest those microscopic droplets contain significant concentrations of mercury, making coastal fog a major source of this neurotoxin in the terrestrial ecosystems of Central California.

The tale begins in 2010, when researchers from UC Santa Cruz discovered dimethyl mercury, a volatile form of the element, in upwelled seawater. Ocean conditions appear to help convert dimethyl mercury into an even more biologically mobile form, monomethyl mercury. The scientists wondered if this upwelled mercury was being incorporated into rain, but found nothing out of the ordinary in rain samples.

Then Peter Weiss-Penzias, a researcher in the school's department of microbiology and environmental toxicology, decided to look for the missing mercury in one more place—fog. "During upwelling, we have this fog bank over the water. Because upwelled mercury is very reactive, it could be oxidized and get incorporated into the cloud droplets, and deposited on the land as fog drip," Weiss-Penzias says.

In 2011, Weiss-Penzias and colleagues collected fog water from two sites around Monterey Bay. They found monomethyl mercury, which is able to accumulate in living tissues, at concentrations up to 100 times higher than in rain.

Their data suggested that the fog samples with the most mercury had been collected immediately after the strong winds that drive ocean upwelling had slackened. "The winds pump mercury to the surface, evaporation is enhanced to the fog bank above, and the fog transports it to land," Weiss-Penzias says.

Now scientists are discovering that fog could be a major source of mercury in upland ecosystems. Coast redwoods rely on fog for moisture in summer. Jim Rytuba of the US Geological Survey in Menlo Park compared the mercury content in redwood needles along the coast and progressively inland as far as Red Bluff. Rytuba reported at the American Geophysical Union meeting this past December that monomethyl mercury concentrations in coastal redwoods were roughly 10 times higher than in their inland counterparts, making fog the dominant source of methylmercury in coastal uplands.

To make matters worse, methylmercury levels have been reported to be rising among yellowfin tuna and in ocean basins over the past 15 years, likely due to industrial activity. "The more mercury we put into the atmosphere with pollution, the more cycling of mercury between the ocean, atmosphere, and land will occur," Weiss-Penzias says.

This is particularly worrisome because monomethyl mercury tends to accumulate in living organisms, especially in species at the top of the food web like pumas and people. For this reason, Weiss-Penzias has begun collaborating with UCSC biologist Chris Wilmers to study mercury levels in mountain lion whiskers.

Weiss-Penzias continues to collect coastal fog samples from Big Sur north to Eureka in search of patterns pointing to mercury production. "We're looking for that smoking gun—where is the environment producing methyl mercury and the mechanism for it getting into fog," he says. KW

Photo: Francis Parchaso

CONTAMINANTS

Sticky Mystery Stumps Spill Responders

The exact identity of the invisible, rubbery, odorless goo that glommed onto some 500 birds on the East Bay shoreline from Alameda to Hayward in January continues to thwart investigators at the California Office of Spill Prevention and Response. Polyisobutylene, a non-biodegradable fuel additive used to keep ship engines clean that has been implicated in the deaths of thousands of seabirds around the world, was the original prime suspect. But state officials quickly ruled it out. Their most recent guess is some type of "synthetic or natural oil or fat" that was deliberately dumped or accidentally spilled into the Bay.

Mike Connor, from the East Bay Dischargers Authority, says his members know the substance did not come from their facilities. "Everyone was evaluating their effluent up the wazoo to see if we found anything funny or out of the usual. But we didn't. And if it was the consistency of a rubber cement type product, it would have clogged all of our filters. We looked intensively at our system and there were no issues, zero toxicity. I'm 98% convinced it was a ship-based source."

Whatever the mystery goo turns out to be, wildlife rescuers, bird advocates, and politicians say the response to these kinds of incidents—whether oil or anything else—needs to improve.

"We weren't notified until early Sunday morning, January 19th, which was probably already 'day three' of the spill," says Wildlife Emergency Services Director Rebecca Dmytryk. "But by noon, we had four volunteers in the field plus three volunteers from International Bird Rescue (IBR), and help from East Bay Regional Parks District. We started collecting birds—we quickly found a dozen alive—but plenty of dead ones."

Unlike during the *Cosco Busan* spill, says Dmytryk, her team saw no goo on the shoreline. "I was curious how shorebirds got impacted—it made me think the substance was brought up into the pickleweed during a king tide." Dmytryk says the goo did not transfer to volunteers' gloves, and contrary to some newspaper reports, was not gray in color: "The birds were just soaked; they looked wet. Their feathers were clumped together. There was no smell."

Volunteers scoured the shoreline from Alameda to Hayward, capturing greasy birds and transporting them to IBR in Fairfield.

Dmytryk is frustrated by the response to the spill. "Between Friday and Tuesday, little was being done by the state because it was a holiday and because it wasn't an oil spill. We need to change this. If the state is charged with protecting our resources but the law (Lempert-Keene-Seastrand) only protects wildlife in a petroleum spill, we need a broader pollution response act." She emphasizes that while the substance may not have been oil, "the birds were dying in the exact same way they do in an oil spill."

Dmytryk says her group did the best they could but they could have saved more birds had there been more trained responders. At the peak of the response, only 12 trained volunteer wildlife responders were working 36 miles of shoreline. "We need at least 1 person for every 2 miles of shoreline. This is yet another wakeup call."

Many surf scoters were oiled in the spill. Inset: Spill victims boxed up for transport. Above: Demytryk and IBR volunteers examine gooey scoter. All photos by: Rebecca Dmytryk

Richardson Bay Audubon Center and Sanctuary's Jordan Wellwood says her organization is working with State Senator Mark Leno to improve the response process. Leno has introduced a bill that will be refined with help from partners like the Audubon Center and BayKeeper.

Over 170 dead birds were collected in the field; 131 birds perished on their way to the rehab center or while under care. At press time, IBR had released 152 birds but still had 41 birds at its hospital. With no state funding to respond to this incident, IBR is spending up to $9,500 per day to care for the birds.

"We're making sure their blood values and temperatures are good; that nothing is left on them that could impair their ability to survive before we release them," says IBR's Russ Curtis. LOV

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MONITORING

Copper Effects on Salmon Influenced by Salinity

Nietzsche was wrong: what doesn't kill you doesn't necessarily make you stronger. Sublethal doses of toxic copper can reduce a salmon's chances of survival, but new research suggests impacts may be different in saltier water.

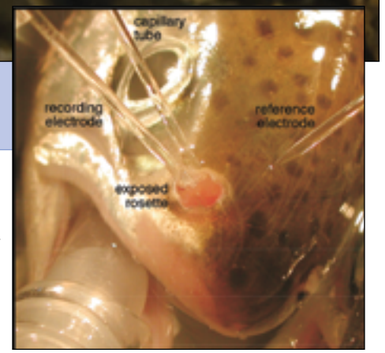
A decade of research by David Baldwin of NOAA's Northwest Fisheries Science Center and other biologists has shown that in some situations, very low levels of dissolved copper interfere with a salmon's ability to detect smells. This can be a matter of life or death: salmon rely on their olfactory sense to avoid predators, locate prey, and home in on their natal streams when they return from the ocean to spawn. Earlier studies involved juvenile fish in freshwater settings. Baldwin's latest project, funded by the Regional Monitoring Program for Water Quality in San Francisco Bay and the Copper Development Association, suggests things are different in brackish and salt water. At salinities that a young salmon is likely to encounter in San Francisco Bay, even copper concentrations well above the current water quality objective had no effect on test subjects' olfactory function.

"As freshwater fish move into the estuary they become, in effect, protected from copper," says Baldwin.

Copper enters the watershed via wastewater discharges, as well as urban and agricultural runoff (some pesticides contain copper), and automobile brake pads. The use of copper in brake pads is now being phased out thanks to state legislation and the efforts of the Brake Pad Partnership (parallel efforts are also in the national pipeline).

To protect all the beneficial uses of Bay, the state's site-specific water quality objectives are 6.9 micrograms per liter (µg/L) for the South Bay and 6.0 µg/L for the Central Bay and San Pablo and Suisun Bays.

Juvenile coho in freshwater phase, pre-smolting. Photo: NOAA Fisheries.



Recent RMP measurements indicate that dissolved copper levels in the Bay are under 4 µg/L, close to what studies in the 1970s found. However, concentrations as low as 3 µg/L have been implicated in behavioral impairment in juvenile salmon in freshwater. They can't detect the chemicals released when another fish is attacked by a predator, and don't take evasive action.

To tease out effects on fish, Baldwin has worked with juveniles — smolts — of both Chinook salmon, a species that travels through the Bay and Delta, and coho, a coastal-stream spawner. Smoltification is a complex process, changing the young fish's appearance and physiology from a freshwater phase to a seawater phase to adapt it for life at sea. Baldwin used electrodes to measure how a smolt's olfactory system responded to a mix of amino acids after exposure to a strong solution of dissolved copper, 50 µg/L, at a salinity of 10 parts per thousand (ppt.) That salinity was chosen because it matches the salinity of the fish's internal fluids and tissues, but it's within the estuarine spectrum.

A seabound Chinook would encounter salinities of 2 ppt where the Sacramento River passes Rio Vista, 7 ppt in San Pablo Bay, and 30 ppt at the Golden Gate.

In Baldwin's lab, while pre-smolted salmon tested in freshwater show a reduced olfactory response due to copper exposure, when tested in 10 ppt there's no reduction. Likewise, in their saltwater phase, copper exposures in 10 ppt appear to have no impact.

Previous freshwater work demonstrated copper olfactory toxicity in a salmon relative, the steelhead, the anadromous form of the rainbow trout. "I don't see why the results of the estuarine/seawater work in coho and Chinook couldn't be generalized to steelhead," Baldwin adds. "It's unlikely that the steelhead olfactory system is radically different."

What's not clear is whether salinity levels below 10 ppt would still be protective. And what about the returning adult salmon, seeking out water that smells like home? That research has yet to be done. But adults have less prolonged exposure to estuarine contaminants than smolts. "Smolts use the estuary as an arena to feed and rear, trying to decide 'Am I really ready to go out in the ocean?'" Baldwin explains. Adults, however, don't dither around on their way to the spawning grounds. **JE**

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RESTORATION

Cullinan Finally in the Fold

Real estate developers often name their projects for what they've displaced: Quail Acres, Live Oak Estates. Egret Bay would have been another such necronym. The 4,500-home development proposed for the former Cullinan Ranch on San Pablo Bay in 1983 would have left little room for egrets, or other birds. A citizen's group, Vallejoans for Cost Efficient Growth, supported by Save the Bay and other environmental organizations, helped kill Egret Bay, and, in a deal brokered by Congresswoman Barbara Boxer, the land became part of the San Pablo Bay National Wildlife Refuge. Then came the process of restoring the badly subsided 1,500 acres to tidal wetland. On January 6, the dike between Cullinan and Dutchman Slough, a tidal arm of the Napa River and San Pablo Bay, was breached in three places, reconnecting the parcel to the Bay for the first time since it was drained and planted in oat hay in the 1880s. The waters rushed in, followed by thousands of canvasback ducks—one of the intended beneficiaries of the refuge—and other waterfowl. "They're taking advantage of the fact that here, all of a sudden, is a food source," says Refuge Manager Don Brubaker. "All you have to do is add water. It's like making oatmeal."

Early plans for Egret Bay, touted by Walden R. Williams of Huntington Beach and backed by secretive Japanese investors, included 3,000 single-family homes selling for $215,000 (equivalent to half a million today), plus condos and boating facilities. The median sales price of a new home in Solano County in 1983 was $126,000. Besides loss of existing wetlands, concerns included traffic congestion on already dangerous Highway 37, problematic water and sewer connections, and the need for 7 million cubic yards of fill. The city of Vallejo bought the proposal, but biologist Francesca Demgen, Robin Leong of Napa-Solano Audubon, and other activists went to court, with support from Save The Bay. The San Francisco Bay Conservation and Development Commission (BCDC) and California Attorney General John Van De Kamp filed parallel suits. The Environmental Impact Statement for the project was rejected, and the US Army Corps of Engineers denied a key permit because of impact on endangered species and inadequate mitigation. Egret Bay lingered for a few years, but Demgen recalls that Williams eventually went away. Boxer's support saved the parcel for restoration.

"It feels fantastic," says Renee Spenst of Ducks Unlimited, who devoted seven years to the Cullinan restoration. "We finally pushed the boulder up the hill." (See "Cullinan's New Crust," *Estuary News*, November 2012.) She calls Cullinan "a challenging project, with a lot of plate-spinning going on to keep everything together." With federal coffers drying up, Spenst helped pull together a network of funding partners to complete the $15 million package. Recreating wetland along three miles of Highway 37 required "delicate negotiations" with CalTrans, and protecting the roadway was complicated by projections of sea level rise.

Canvasbacks at Cullinan. Photo: Russell Lowgren

"The waterfowl response to the breach was almost instantaneous,"

continued to back page

TECHNO FIXES

Tunable Infrastructure

Bradley Cantrell is a computational landscape architect and a professor at Harvard's Graduate School of Design. He's interested in using sensors and algorithms to improve the relationship between natural systems and the built environment.

By combining historical data and predictive modeling about a specific watershed, Cantrell thinks infrastructure built to control water flows—dams, levees, and the like—can become more adaptable and provide better ecological value.

Before joining the Harvard faculty, Cantrell taught at Louisiana State University where he and his students developed a theoretical way of bolstering the Gulf Coast's estuary. The region suffers from a rapidly declining salt marsh—some estimates have it that Louisiana loses a football field-sized chunk of marsh hourly.

One reason for the salt marsh decline is that the sediment funneled through the Mississippi River is not getting to the Gulf in sufficient quantities. A half-century worth of aggressive flood control and optimization for deep-water navigation is the main culprit.

To reinstate the natural function of the river basin, Cantrell came up with a device called a "PodMod" that captures upriver sediment in mesh tubes and deposits it downriver, once clear of intervening infrastructure. A filled tube activates a float, which travels until it meets brackish water. The increased salinity activates electrochemical corrosion, which in turn opens a clamp, letting loose the load of sediment. The pods can be tagged, tracked, and timed to match seasonal flows and optimal river output—or even to miss times of heavy boat traffic.

Cantrell proposed a trial of the system on the Atchafalaya River, a tributary of the Mississippi. The system, however, is not part of the current $50 billion *Coastal Master Plan* that guides current restoration efforts.

While the PodMod idea might not be a good fit for the hydrology of the San Francisco Bay estuary, which also suffers from poor natural sediment recharge, Cantrell's larger concepts about using technology to make infrastructure better mimic natural systems might still be locally applicable. In fact, some of Cantrell's Harvard design students are modeling West Oakland and trying to devise simple systems to capture industrial air pollution. **DM**

ENDANGERED

Good Old Days for Smelt

The ongoing drought may have pushed the Delta smelt to the brink of extinction, with the species plummeting to its lowest level ever, according to UC Davis biologist Peter Moyle in a recent interview on Capitol Public Radio. Yet a new report released by the Interagency Ecological Program found that just a few years ago, in 2011, the slim silver fish had a banner year, which showed that the smelt has the ability to rebound, if conditions are just right.

According to the report's co-authors, the smelt's temporary rebound in 2011 showed that, at that time, the system had not reached such an altered state that it could not longer support native species. It also showed that smelt can thrive when conditions are good for spawning, growth and survival.

A general life cycle conceptual model for the four Delta smelt life stages of adult, eggs and larvae, juvenile, and sub-adult—as well as life stage transition conceptual models—generated 16 hypotheses about factors that may have contributed to the 2011 increase. The authors then evaluated these hypotheses by comparing habitat conditions and Delta smelt responses in the wet year 2011 to those in the wet year 2006 and in the drier years 2005 and 2010. Although larval recruitment was high in both wet years and lower in the earlier drier years, juvenile and adult abundance increased only in 2011. The lack of juvenile and adult abundance in 2006 might have been due to poor survival of larvae to juveniles in 2005-2006.

Other factors helping make 2011 a good year were prolonged cool spring water temperatures and high 2011 winter and spring outflows—which reduced entrainment and possibly improved other habitat conditions—plus better food availability in late spring. Juveniles benefitted from cool water temperatures in late spring and early summer as well as from improved food availability and low levels of harmful Microcystis. And sub-adults benefitted from improved food availability and favorable habitat conditions in the large, low salinity zone, which was located more toward Suisun Bay in 2005-2006 and 2010. The authors conclude that while good larval recruitment is essential for a strong year class, increased growth and survival in subsequent life stages are essential to support healthy smelt populations.

The authors point out that the report benefited from years of monitoring data, although some data gaps still exist. While they did not reject any of their hypotheses entirely, comparisons of other habitat attributes either produced inconclusive results or were limited by a lack of suitable data.

DWR's Ted Sommer, one of the authors, says the report breaks new ground because the model it presents is the "most refined version" of all of the conceptual models used to date. "It reflects the progress we've made in the past decade figuring out the factors important to Delta smelt, organized all in one place." And the report isn't sitting on a shelf but is already being applied to "real time" ecosystem management. "We're using the model to help us identify what things to measure and which questions to ask." **LOV**

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CLIMATE CHANGE

Thirsty Thistle Irks California

On wind and waves, in ballast water and packing crates, on fishing gear and in the guts of birds, invasive organisms keep coming. In a perverse synergy, climate change is opening new pathways for them and broadening the habitats in which they thrive. A new report by the Ad Hoc Working Group on Invasive Species and Climate Change, *Bioinvasions in a Changing World*, outlines the novel challenges and the tools available for natural resource managers who will have to meet them.

Warmer temperatures and drier conditions will give some invasive plants a boost, according to Doug Johnson and Elizabeth Brusati of the California Invasive Plant Council, local members of the working group. "More extreme weather events could spread species more, through strong winds and storm surges," says Brusati. "Extreme events could create disturbances, opening up areas invasives could get into." Johnson adds that shorter shipping routes through a warmer Arctic would improve survival odds for ballast stowaways and forest pests in wood packing.

Cal-IPC's onlineWeed Mapper tool helps alert land managers to invasive plants that may be approaching their areas, modeling where suitable habitat will be 35 years from now. Potential problems for the Estuary region include Saharan mustard, Spanish broom, Sakhalin knotweed. Some, like the broom, build up fuel loads that exacerbate wildfires. Others are water-guzzlers. "Yellow starthistle consumes an extra million acre-feet every year in the Central Valley alone," says Johnson. Researchers are also investigating more subtle effects, impacting the soil's ability to hold carbon. "We're looking at Sierra meadows, the sponges for water resources," he adds. "From what we know, weeds can dry out wet meadows, and drier meadows hold less carbon. We need to find out more about how big an impact this is."

Yellow Star Thistle. Photo: Bob Case

Local weed warriors use some of the decision tools mentioned in the Ad Hoc Group's report. San Francisco-based PlantRight is adapting an Australian model to assess risks of drought-tolerant exotic plants introduced by the horticultural trade, looking to build in climate variables. Ironically, some plants recommended by the US Department of Energy as biofuel stocks are known invasives. For those, we'll need guidelines for best management practices. "For all the new pathways," Johnson says, "we'll need to be as diligent as we can and smart about how they might change over time." **JE**

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SCIENCE

Master Variables Questioned

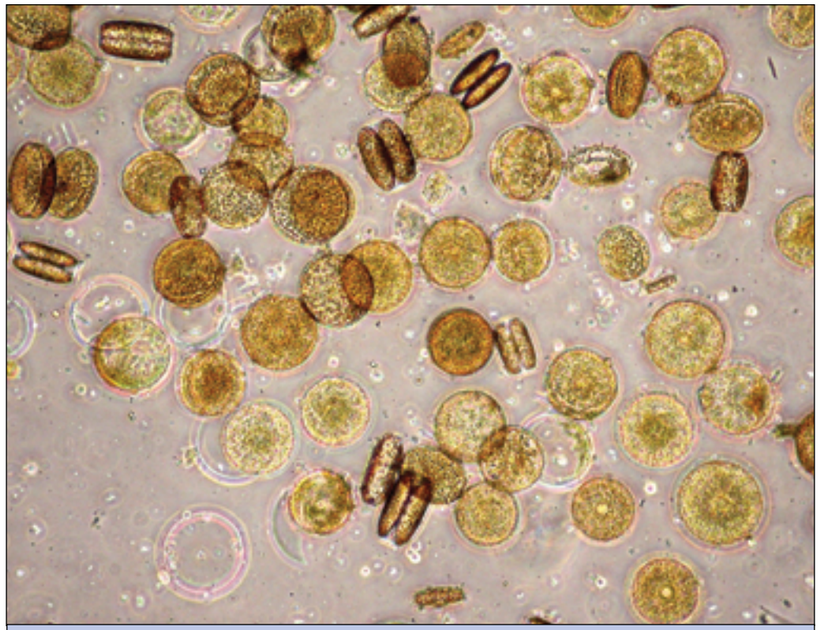
It isn't your grandfather's Estuary — or even your father's. Changes have rippled through the food web from seasonal shifts in the growth of microscopic diatoms to a sharp decline in pelagic fish. "It's a hyper-disturbed ecosystem," says US Geological Survey aquatic ecologist James Cloern.

As the changes have grown more alarming, everyone has been searching for a single culprit. Some have been pointing the finger at ammonia from a regional sewage treatment plant and others at everything from the loss of river flows to too many hungry alien clams or bass. But in such a disturbed system things are rarely simple. "We can't attribute the restructuring of the biological community to a single factor," says Cloern. "There's broad scientific consensus that landscape transformation, water diversions, toxics, introduced species, and nutrient loads are all involved." Consensus or not, in the delta there always seems to be a devil in the details, especially when it comes to how nutrients like nitrogen affect the ecosystem.

Nitrogen is vital to phytoplankton, the single-celled photosynthesizers, including diatoms, responsible for primary production in aquatic ecosystems that fuels the food web. But the value of nitrogen depends on its chemical form. Ammonium, one kind of nitrogen compound, can interfere with the ability of phytoplankton to use nitrate, another compound, to produce food for fish. Nitrogen enters the estuary system from wastewater treatment plants and agricultural runoff.

Recent paradigms explaining change in the Estuary identify nutrient loads, mainly from the Sacramento Regional Sewage Treatment Plant, as a master variable. That view, represented by Patricia Glibert of the University of Maryland Center for Environmental Science and Richard Dugdale of San Francisco State University's Romberg Tiburon Center, has been one of the foundations of proposals for substantial technological changes at the wastewater treatment plant.

An article by Cloern and six co-authors in the current *Interagency Ecological Program Newsletter*, however, argues that it's highly uncertain that such measures will be enough to recover the Estuary. Reanalyzing data on Suisun Bay, they question in particular Glibert's linkage of nutrient trends to food web changes and her prescribed technological fix.



Centric diatom forms that dominated summer blooms in Suisun Bay before the 1987 establishment of the invasive clam Potamocorbula*, which eliminated summer blooms by its fast water filtration. Photo: Cary Burns-Lopez, USGS*

Glibert contends that reducing ammonium inputs "is essential to restoring historic pelagic fish populations" in a 2010 article in *Reviews in Fisheries Science* analyzing data from the Interagency Ecological Program's (IEP) Suisun Bay samples and other Estuary sources. If that isn't done, she says, "other measures, including regulation of water pumping or manipulations of salinity, as has been the current strategy, will likely show little beneficial effect."

In addition to ammonium, Glibert points to increased ratios of nitrogen to phosphorus that select against diatoms, high-quality food for other organisms, and favor cyanobacteria and other lower-quality foods, leading through multiple trophic steps to the collapse of the pelagic food web. Freshwater flows, to Glibert, are a secondary factor. (At press time, Glibert was traveling in China and unavailable for an interview.)

Dugdale, who calls himself "a stranded oceanographer," emphasizes the Ammonium Paradox: "Phytoplankton, especially diatoms, are specialists in using nitrate, gobbling it up incredibly fast. But their nitrate uptake is inhibited by even low amounts of ammonium."

Dugdale also underscores the interaction between freshwater flow and ammonium. "You need a certain level of flow in order to dilute the ammonium concentration being put out by the treatment plant," he says. Too little flow and there's not enough dilution to allow phytoplankton to exploit the nitrate; too much and the phytoplankton are washed out of the system. "When ammonium declines to non-inhibiting levels, you start to get nitrate uptake and explosive growth. We see it in enclosure experiments and in the field." Dugdale and others argue that "changes in water treatment practices and water allocation" could reduce ammonium inputs in a 2007 article in *Estuarine, Coastal and Shelf Science*.

If nutrients have driven the downshift in phytoplankton, argue Cloern and his co-authors in their recent article, you'd expect the curve for declining chlorophyll-a concentrations, an indicator of phytoplankton biomass, to mirror the curve for increasing nutrient loads. But it doesn't. Instead, there's a step change

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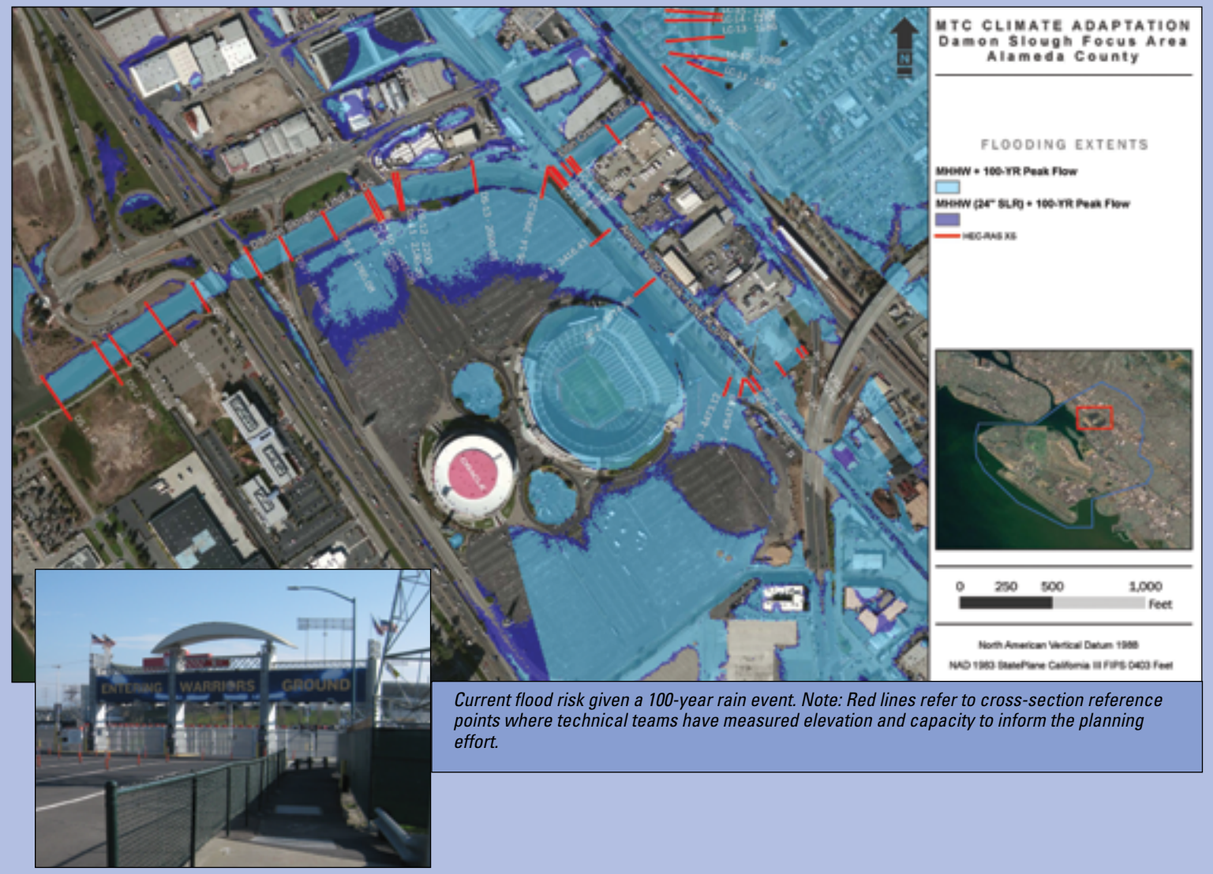
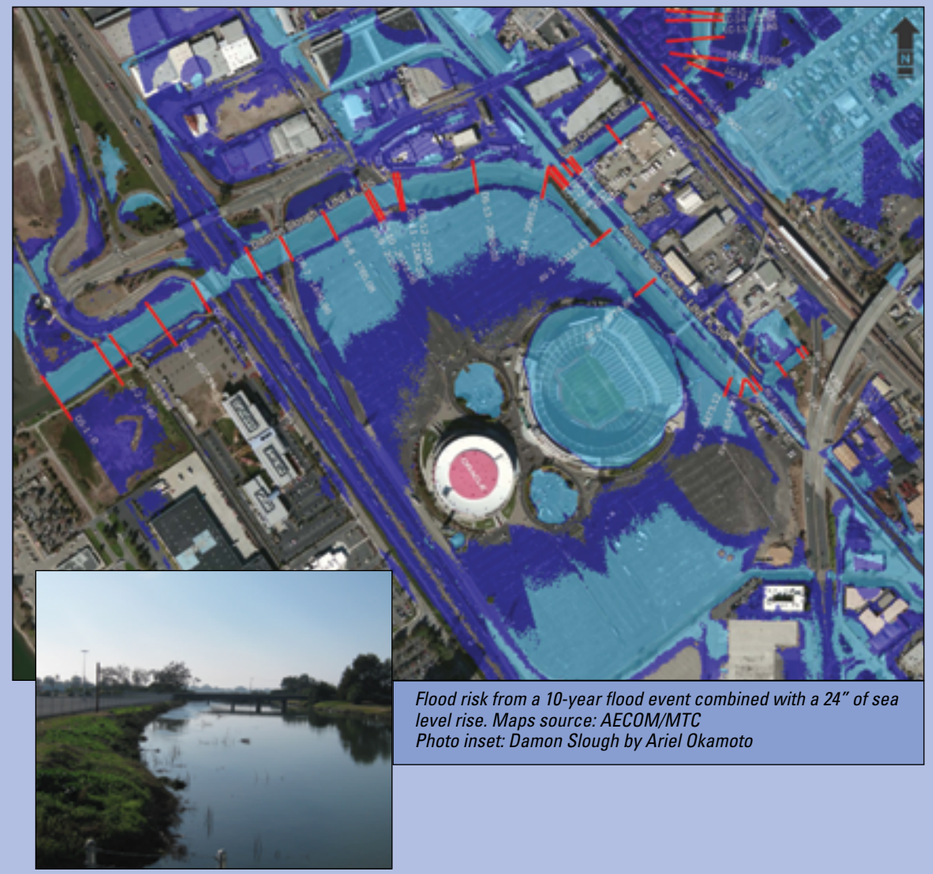
F L O O D I N G

Oakland Coliseum Area Looks Vulnerable



Current flood risk given a 100-year rain event. Note: Red lines refer to cross-section reference points where technical teams have measured elevation and capacity to inform the planning effort.



Flood risk from a 10-year flood event combined with a 24" of sea level rise. Maps source: AECOM/MTC
Photo inset: Damon Slough by Ariel Okamoto

PREVIEW

An upcoming article will explore how local and regional agencies are working with the BCDC ART project to prepare for more flooding in the area around the Oakland coliseum and Damon Slough due to sea level rise. Even slightly higher water levels can mean significantly more flood risk when combined with a storm, earthquake or other extreme event. For planners, the coliseum area presents both challenges and opportunities. Challenges include many very vulnerable, and not so mobile, elderly and low-income communities, as well as vital transportation infrastructure (airports, BART facilities, and freeways) to protect. Opportunities include open space, in the form of the coliseum's vast parking lots, for adaptive management strategies like increasing the capacity and habitat zone around Damon Slough, as well as recreational space. Read about it in-depth in the June issue of *ESTUARY News*. For more info: www.adaptingtorisingtides.org

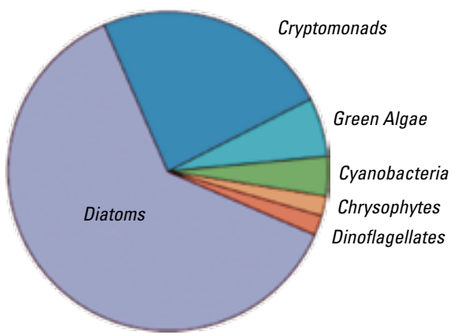
VARIABLES, *continued from page 7*

in IEP data from Suisun: a precipitous drop to lower — and stable — levels in 1987. (Dugdale sees evidence of a decrease prior to that; Cloern's group found no statistically significant evidence.)

The drop coincides with the advent of the invasive overbite clam (*Potamocorbula amurensis*), a voracious filter-feeder that vacuums diatoms out of the system. Cloern's group also found no support for reports of a shift from "good" phytoplankton to "bad" phytoplankton. The earlier IEP samples, Cloern says, don't meet standard reliability criteria, while more recent and more robust data show a continuing preponderance of diatoms in a reduced phytoplankton biomass. "There's no evidence that phytoplankton now has poorer food quality," he says. The problem is not quality but quantity.

Dugdale acknowledges complications: his model doesn't completely fit what's happening in places like Suisun Bay, where his research group has suggested that "some unknown factor" appears to selectively depress nitrate uptake in experimental enclosures. Possible culprits could be trace metal leakage from the "mothball fleet" and herbicides. Dugdale's associate Sarah Blaser previously found two herbicides, diuron and imazapyr, had adverse effects on phytoplankton. Diuron is used on weeds and in antifouling paint for boats, while imazapyr, a workhorse in invasive *Spartina* control, has been deployed against another invasive exotic, pepperweed, at the Rush Ranch preserve in Suisun Marsh. The magnitude of their impact is unclear.

The Central Valley Regional Water Quality Control Board's Delta Strategic Workplan includes a Delta Nutrient Strategy which calls for research to determine the role of nutrients in problems such as increased abundance of aquatic weeds, low dissolved oxygen in back sloughs, and cyanobacteria blooms, as well as changes in phytoplankton community composition. As part of the research plan, the Board is convening a Science Work Group to investigate first the Ammonium Paradox,



Most phytoplankton biomass in Suisun Bay is composed of diatoms and cryptophytes, two high-quality food resources for consumers. This summary from 152 samples collected by USGS between 1992-2014 suggests that the pelagic organism decline cannot be explained by a shift in phytoplankton toward species having low food quality.
Source: USGS

then Glibert's model, with a report due in 2018. Dugdale, Glibert, and Cloern's co-author David Senn are on preliminary lists of work group members and presenters.

"The most important decision about ammonium reduction has already been made," says Dugdale. The Sacramento regional plant has a new permit for advanced secondary treatment that requires most ammonium to be converted to nitrate and will also reduce the total nitrogen output. Pilots are running, and the new system should be on line in 7 or 8 years: "It will be a grand experiment at that point."

Cloern agrees that the new treatment will have environmental benefits: "My question is this: what will be the outcome of the experiment and will some be disappointed if there is the expectation that this single action will lead to recovery of the ecosystem?" JE

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NOMINATE YOUR FAVS

Outstanding Environmental Projects

The Friends of the San Francisco Estuary seeks nominations for outstanding environmental projects that benefit the San Francisco Bay-Delta Estuary and its watersheds. Projects with significant achievements will be featured at the September 2015 State of the Estuary Conference and awards presented to the responsible organizations. Nominated projects should fall into one of the categories in the San Francisco Estuary CCMP, available at www.sfestuary.org/about-the-estuary/documents-reports/

Nominations must be received by mail or e-mail to the Friends of the San Francisco Estuary at friendsofsfestuary@gmail.com or P.O. Box 791, Oakland, CA 94604. Deadline is Tuesday, June 30, 2015. For details: www.sfestuary.org/soe

Jean Auer Environmental Award

The San Francisco Estuary Partnership seeks nominations of individuals who have made a significant contribution toward improving environmental quality in the Estuary. An award, given in memory of Jean Auer, will be presented to the selected recipient at the conference. People may be nominated from the public or private sector. Individuals working on water-related issues will receive special consideration.

Nominations must be received by mail or e-mail to the San Francisco Estuary Partnership at darcielu-ce@gmail.com or 1515 Clay Street, Suite 1400, Oakland, CA 94612. Deadline is Tuesday, June 30, 2015. For details: www.sfestuary.org/soe

Ridgway's Rail, one of the region's most endangered species. Photo: Rick Lewis

C C M P C O R N E R

A New Comprehensive Plan for the Estuary

Changing estuarine conditions and new pressures from ongoing urbanization and development, as well as from climate change, inspired estuary planners to undertake a revision to the *Comprehensive Conservation and Management Plan* (CCMP) in 2014. The CCMP, first published in 1993 and most recently updated in 2007, was the first master plan for improving the health of the estuary encompassing San Francisco Bay and the Sacramento-San Joaquin River Delta. The intent of the current update — a project still led and managed by the San Francisco Estuary Partnership (SFEP) — is to streamline the current plan, which contains more than 200 actions, and refocus on contemporary concerns.

"We're now seeing the forecasts for faster rates of sea level rise and lengthier periods of drought come true. We're having to revise our plans in anticipation of a much more tumultuous future for estuary's wildlife and for Bay Area residents," says Marc Holmes of The Bay Institute, one of the early and current framers of the CCMP.

"So much has changed since 2007 that has a direct impact on the Bay and Estuary," says Carol Mahoney of Zone 7 Water Agency, who is also working on the CCMP revision. "From legislative actions like SBx7-7 (20% water conservation by 2020) and the local plastic bag bans to greater use of stormwater clean up and capture technologies, new fronts have opened up to help assess and protect this vital resource in our own backyard."

Since *ESTUARY* last reported on the CCMP update project in December, SFEP staff has pulled together a list of draft actions developed by teams made of experts and members of a steering committee. Draft actions revolve around three topic areas: habitats, living resources, and water quality and quantity. Next steps will involve soliciting feedback from the larger Bay Area community, and review of the draft actions by the steering committee working under SFEP's Implementation Committee.

"The teams have really rolled up their sleeves and proposed a robust set of possible actions," says Caitlin Sweeney, a senior planner for the Partnership. Sweeney is now working with each team to cross reference and refine proposed actions across program areas. "Everyone is much more aware these days of how every action affects others," she says.

As mentioned in the December article, the revised CCMP will look forward to 2050 while crafting a small set of strategic actions that can result in measured progress over the first five years of implementation.

"We continue to harness the big picture spirit and strong partnerships of the first CCMP in this new revision," says Partnership director Judy Kelly.

SHORT HISTORY OF THE CCMP

The San Francisco Estuary Project had its origins in the Clean Water Act, and its purview is one of the America's 28 "estuaries of national significance." In 1987, the Project began assembling a series of ground-breaking status and trends reports on key environmental and management issues troubling San Francisco Bay and the Delta — linking them into one estuary for the first time. Building on this foundation, it developed the strong vision for addressing these issues now known as the CCMP.

"The first time we took a serious look at the estuary in a comprehensive way was the CCMP. All successive efforts have built on that foundation," says western water consultant Barry Nelson. Nelson was one of more than a hundred stakeholders from diverse interests, ranging from business and environmental groups to government agencies, invited to pull up a chair at the negotiating table. The resulting 300-page CCMP aimed to restore the ecological functions of an estuary that drains almost forty percent of the state, while at the same time sustaining its use by humans and wildlife.

Recent breach at Cullinan Ranch in the North Bay, testimony to the tenacity of wetland and wildlife activists and public interests working to bring a complicated, expensive, time-consuming restoration project to fruition (see p.5). Photo: Marc Holmes

Within the CCMP process, stakeholders winnowed their ideas down to 145 specific actions tackling pollution, dredging, land use, water use, wetlands, fish and wildlife issues, among others. "The CCMP provided a structure for allowing people to do what they care about—a kind of church of the estuary," says Will Travis, former director of the San Francisco Bay Conservation and Development Commission (BCDC).

On the 20th anniversary of the CCMP, the Partnership published a special 24-page issue of ESTUARY News magazine. The issue summarizes twenty years of progress, including everything from planting root balls of eelgrass in the mudflats to warning the public about the dangers of eating too much Bay-caught white croaker. This snapshot review suggests that almost 600 projects, undertaken by diverse partners, have implemented the CCMP in some way or another in the last 20 years.

Many of the more obvious results of the CCMP include cleaner water, stronger science, nearly 50,000 acres of wetlands in some stage of restoration, thousands of volunteers involved in hands-on stewardship, and whole rivers returned to their floodplains. Much of the progress comes thanks to the investment of taxpayers in state water bonds.

NEW CHALLENGES & ACTIONS

Asked about how the proposed new CCMP will be different from the last one, Kelly had this response: "Clearly regional climate change adaptation is going to be a major theme as we plan for the next 35 years. In addition, new water quality issues such as contaminants of emerging concern are taking their place as areas of possible focus alongside long-standing concerns about legacy PCBs and mercury."

According to Sweeney, some of the more immediate priority actions CCMP revision teams are considering in their drafts include:

- Leveraging natural processes through "green" infrastructure to provide multiple benefits such as flood protection, aquatic habitat, and water quality.
- Developing freshwater inflow standards to protect all beneficial uses in the Estuary.
- Addressing emerging contaminants.
- Planning for extended droughts.
- Protecting and increasing fish and wildlife populations.
- Restoring and sustaining ecosystems, and increasing the adaptive capacity of our shorelines, in the face of climate change.
- Developing and sustaining reliable funding sources and collective leadership to meet our future goals.

"We are already working with our partner organizations in small group settings to explain the process and get feedback and ideas for the new plan," says Kelly.

continued to back page

PUBLIC OPINION

WHAT'S YOUR TAKE?

The San Francisco Estuary Partnership welcomes your input!

> CHALLENGES ?

What are the 3 biggest challenges now facing the San Francisco Estuary?

> ACTIONS ?

What are the 3 most important actions we can take for a healthier estuary over the next five years?

> CONTACT ?

How can we get in touch with you?

YOU CAN EITHER:

1. Go online and answer these questions at www.sfestuary.org/ccmprevision/
2. Type up your responses and mail them to Caitlin Sweeney, SFEP, 1515 Clay Street, Suite 1400, Oakland, CA 94612

   Or:

   Caitlin.Sweeney@waterboards.ca.gov

Moffett Field near Sunnyvale, just one property on the long shoreline between San Francisco and San Jose which is threatened by continued urbanization and vulnerable to sea level rise. Photo by Marc Holmes.

San Francisco Estuary Partnership
1515 Clay Street, Suite 1400
Oakland, CA 94612

www.sfestuary.org

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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COVER PHOTO *Belmont Slough flanked by Foster City and Redwood Shores*
Marc Holmes

CULLINAN, *continued from page 5*

recalls Brubaker: up to 4,000 ducks showed up. Ducks Unlimited biologist Craig Garner estimates around 2,000 canvasbacks. During high tides, stilts, avocets, and other shorebirds are using the 16 oblong marsh mounds engineered into the project. Egrets, grebes, and cormorants have also been observed foraging for aquatic prey.

San Francisco Bay is the most important wintering location on the Pacific Flyway for canvasbacks, and most concentrate in San Pablo Bay. Thirty years ago, biologist Warren Reinecker estimated that 80 percent of the flyway's canvasbacks used San Pablo Bay. Numbers have fluctuated, but there are still lots of these handsome white-backed diving ducks. Brubaker notes that canvasbacks, while recovering from earlier lows, "are still not doing as well as we'd like." Locally-wintering birds may have nested anywhere from Alaska to Alberta, experiencing the effects of climate change, resource extraction, and agricultural expansion.

As sediment accretes, Cullinan will also become habitat for the endangered Ridgway's rail (formerly called the California clapper rail) and salt marsh harvest mouse. Refuge managers hope to jumpstart that process on 290 acres with dredged material from the Mare Island dry docks. "BCDC came to us over a year ago about beneficial reuse," says Spenst. Brubaker says all the permits are in place and pumping could start any day now, hastening the day when the refuge can start farming mice and rails.

On the day of the breach, Demgen looked back: "Today we are witnessing how wildly successful a handful of committed folks supported by a large group of believers can be!" If Egret Bay had gone through, she says, "the North Bay would have gone down like dominoes." What could have become Foster City North, an entering wedge for the development of the San Pablo Bay shoreline, is now a key piece of a mosaic of protected tidelands. **JE**

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CCMP, *continued from page 11*

Later this spring, the Partnership will start a wider outreach effort. By the next State of the Estuary Conference, set for September 17th and 18th at the Oakland Marriott, the Partnership hopes to have a complete first draft of the 2016 CCMP ready for review and comment.

"One of the issues commonly cited as a big challenge in restoring the ecological functions of the estuary is that there are so many different agencies and jurisdictions involved," says Letitia Grenier, lead scientist for the 2015 *Baylands Ecosystem Habitat Goals Update*, which includes new science and recommendations to be considered in fleshing out the new CCMP. "The CCMP is one of very few regional plans that treats the full estuary as a single system, recognizing that actions and changes in one part of the system will affect the other parts, and championing strong integration across different planning efforts." **ARO**

For updates on CCMP development: www.sfestuary.org/ccmp-revision

Note, this article partially excerpted and adapted from *ESTUARY News* Magazine, October 2013, CCMP 20th Anniversary Review issue.