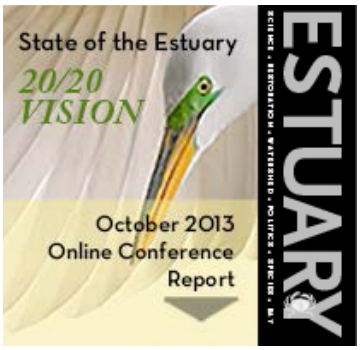

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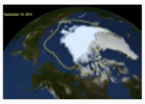


Choosing a Future for the Bay

It's tempting to look at today's healthier Estuary and call it a job well done. But surviving global warming will mean incorporating climate-smart conservation considerations into all aspects of land use practices and natural resource management. READ ON

Investing in Flood-Resistant Shorelines

Low-lying Silicon Valley is at the mercy of a rising Bay. South Bay businesses now have flood risk on their radar, while the region turns to natural habitat restoration for safety. READ ON

One Estuary, Many Plans

The state is poised to make major decisions on water allocation, habitat restoration, and climate change adaptations in the Delta. The leaders of state agencies charged with implementing these management plants discuss how they work together to ensure a healthier Estuary. READ ON

Tracking Next Generation Pollutants

San Francisco Bay appears to be losing its historic resistance to nutrient pollution. Recent state efforts to regulate chemical pollutants should help safeguard water quality, and could benefit from the experience of other countries that have already started down that road. READ ON

Tuesday Plenary I:

Choosing a Future for the Bay

By Ariel Rubissow Okamoto

Clean Water History, Climate Change, Shellhammer Award

Andy Gunther opened the 11th Biennial State of the Estuary Conference by calling a spade a spade. "Many elected leaders are in complete denial about climate change, supported by a misinformation campaign," said Gunther. His comment kicked off a conference where nearly every session included remarks on the challenges global warming poses to the San Francisco Estuary. "We're not in Kansas anymore," said Gunther, who coordinates a collaboration of scientists and resource managers called the Bay Area Ecosystems Climate Change Consortium. This group has been warning that it will take far more than ruby slippers to rescue our wetlands, wildlife and water supplies, not to mention our airports and freeways, from the twin witches of rising seas and shifting snowpack. "Expectations based on the past are no longer enough. The entire meaning of conservation and restoration is changing. The future we get is going to be the future we choose," said Gunther.

But local elected officials aren't sure how to choose without stepping on the toes of cities and counties long used to making their own land use decisions. Indeed, the region has struggled for decades to strengthen regional planning, especially on environmental fronts such as clean air, clean water, and public transit. The specter of climate change could spur more support for regional cooperation, said the second speaker Julie Pierce, Mayor of Clayton and Vice President of the Association of Bay Area Governments. "We must adapt now to protect our way of life, our economy, all we hold dear," she said.

A lot of what we hold dear, in terms of our water supplies and aquatic resources, has been protected by the efforts of Bay guardians: the San Francisco Estuary Partnership, two Regional Water Quality Control Boards, and the Bay Conservation & Development Commission, in addition to federal and state agencies charged with environmental protection and natural resource management. Working with business interests, non-profits, and citizen groups, these regulators and collaborators have helped the 12 counties around the estuary save fish, protect water supplies, restore wetlands, and curb pollution over the last 20 years; all hope to achieve much more in decades to come.

The next two conference speakers reflected on the conference's theme of 20/20 vision on the past and future. "When the public thinks about San Francisco Bay, they think of it as being protected," said Jared Blumenfeld, regional administrator for the U.S. Environmental Protection Agency. "It's protected by the people in this room. It's not up to the next generation, it's up to us." Blumenfeld observed that while environmental protection may be moving slowly in Washington, DC these days, in the 1970s the federal government passed important national legislation to protect our air, water and endangered species in quick succession. "The Clean Water Act is still the law of the land," he said.
One of those landmark laws, the Clean Water Act, includes a tool that has been used to admirable effect in the Bay and Delta regions: TMDL, or total maximum daily load. Water quality regulators and polluters use TMDLs to implement regional limits on the discharge or runoff of contaminants. TMDLs help regulate substances ranging from eroded sediment and

plastic trash to trace metals and pesticides. The Bay Area has some of the strongest TMDLs in the nation, with 27 TMDLs approved in the Estuary watershed, and 15 more in progress, according to Blumenfeld.

The region has also invested in some of the best water quality monitoring programs around, and in the environmental literacy of the public, said Blumenfeld. He encouraged the audience to support the State Water Resources Control Board's current efforts to update California water policy: "We don't want to be the skunk at the party. We need bring up the Clean Water Act early and often. We need to think about it as the floor, not the ceiling, of what can be done."

The next speaker also reflected on successes in estuarine planning and management over the last 20 years, especially those envisioned by the San Francisco Estuary Partnership's 1993 Comprehensive Conservation and Management Plan (CCMP). Steve Ritchie—who in his career has worn federal, state, local and regional hats—was better equipped to take stock than most. "I'm one of the few signatories of the original CCMP who's still around," he said. Only a smattering of other folk in the room that day, most white-haired, could claim the same. Ritchie was head of the Regional Water Board at the time but now works for the S.F. Public Utilities Commission, which spent the summer battling wildfires around the city's reservoir in Yosemite. "The Rim Fire was an important reminder of the connection between our homes and our watershed—it threatened the quality of drinking water in San Francisco," said Ritchie.

Ritchie gave a succinct review of significant achievements since the fateful signing of the CCMP. First came the 1994 federal-state Bay-Delta Accord, which paved the way for new water quality standards to protect estuarine health and native fish. After that, a whole series of statewide bond measures dedicated $16.5 billion to California's water quality, wetlands, and conservation programs. As a result, "Conservation is an ethic urban water agencies now live and breathe every day," said Ritchie. Most notably in the Bay Area, the Santa Clara Valley Water District "took the bull by the horns" in water recycling, he said. And he reminded his audience that the face of the Bay shoreline has been transformed by the habitat restoration of 16,500 acres of former salt ponds.

Other achievements Ritchie ticked off his list included the establishment of a robust science program around Delta native fish and water supply issues, which became known as CALFED; the push to get municipalities to better manage stormwater via establishment of the US EPA and Regional Water Quality Control Board; and state insistence on the development of more integrated regional water plans, or IRWP. These interdisciplinary, collaborative initiatives around science and watershed management are part of the wave of the future, according to Ritchie: "The idea of a single-purpose agency going off and doing its own thing doesn't work anymore." Ritchie remained circumspect, however, about whether the 2009 Delta package and subsequent planning efforts around the state's coequal goals of sustaining both the ecosystem and human water supplies would fly.

When Ritchie spoke about the future, he said we still haven't agreed on what "fixing" the Delta means. But he was hopeful about securing more money for estuarine restoration through a new water bond, and the fledgling San Francisco Bay Restoration Authority. He said he was reassured that water recycling was gaining popular support, and that we would all

soon be "drinking well-treated sewage." He argued that rising seas and falling bank balances would shift the region's restoration and water quality priorities: "Change is inevitable. Regulations try to maintain status quo but you can't. That's the nature of evolution." Evolution, of course, also includes that most primal of all human activities: reproduction. The planet's population exceeded seven billion in late 2011, said the next speaker, Ellie Cohen, before mentioning other assaults on the carrying capacity of planet earth: 43 percent of the planet's land surface is now covered with agricultural and urban development; carbon dioxide levels reached 400 parts per million in 2013 for the first time in human history; Arctic ice reached the lowest extent and volume ever recorded in 2012; and extreme weather events are on the rise, as exemplified by Sandy's 17-foot-high storm surge and, closer to home, California's current drought and 2013 Yosemite Rim Fire.

All of these events, Cohen said, bear out scientific projections pointing to more droughts, more storms, higher seas, higher temperatures, and big ecological upheavals. "Are we at tipping point for the future of life on this planet?" asked Cohen, who directs Point Blue Conservation Science. "That depends on what we do in the next five, ten, or fifteen years. But we can't forget that we are still utterly and completely dependent on nature's benefits for our very survival."

Nature provides food, fiber, energy, water, and air, with a value estimated at two times the global GNP ($72 trillion in today's dollars). To sustain life as we know it, said Cohen, requires what she calls Climate Smart Conservation in land use practices, environmental protection programs, and natural resource management. This approach revolves around key concepts such as focusing on the future, designing within a watershed and ecosystem context, being flexible and adaptive, and giving priority to actions with multiple benefits. It also includes collaborating and communicating. "We need to break out of our siloed world," she said.

Cohen offered numerous examples of climate smart actions ranging from prohibiting new development in places highly vulnerable to storm surges to restoring wetlands as buffers for urban infrastructure. She called for protecting food web hot spots in the ocean and Bay when considering the placement of shipping lanes or offshore wind farms, and scenario planning considering multiple possible futures in every organization tasked with land, water, and wildlife management. "Climate change is accelerating and exacerbating other environmental problems. We're not going to have the money we need, or the time we need, so we have to test and experiment constantly, and apply what we learn. No more business as usual," she said.

Small Mouse, Big Protector

At the conference, Howard Shellhammer accepted the Jean Auer Environmental Award for his contributions to improve environmental quality in the Bay-Delta Estuary. Carl Wilcox, Bay Delta Regional Manager with the California Department of Fish and Wildlife, presented the award, recalling that when he came to Bay Area in the 1980s, the plight of the endangered salt marsh harvest mouse influenced many decisions about shoreline development and preservation.

Shellhammer accepted the award "on behalf of all the biologists who have done so much to understand the biology of marshes of Bay." A former San Jose State biology professor, Shellhammer has spent half a century studying the endangered salt marsh harvest mouse. His careful work established that the mouse needs drier, higher upper marsh habitat to escape during extra-high tides. Connecting existing marsh fragments with restored, converted former salt ponds, he found, would enable populations to interbreed and restock once-isolated marsh remnants. In recent years, he's been writing poems about the creatures and places he's studied and loved.

The worth of salt marsh harvest mice?

What a wondrous experience
to sit at the edge of a salt marsh
and hold a beautiful little mouse,
small and docile, soft and shy.
Why worry about such a mouse
when markets are worrisome and gas is high?
It matters because when species disappear
they disappear forever and we have less.
I've worked to save the marshes
and to save this little mouse
so that in the future there will be
marshes down at the edge of the bay
and in them salt marsh harvest mice,
little mice that have the right to be there
no matter how small or hidden from sight.
You'd understand if you could see one
in a salt marsh in dawn's early light.
–Howard Shellhammer

Tuesday Plenary II:

Investing in Flood-Resistant Shorelines

By Ariel Rubissow Okamoto & Joe Eaton

Sea Level Rise, Infrastructure, Wetland Buffers, Be the Street

The tone of the speechmaking changed when Carl Guardino stepped to the podium for Tuesday's second morning session. Suddenly the audience was listening not to insider views of science and government, but to an outsider alarmed by the uncertainties of climate change. "It's our job as CEOs not to cheer or jeer, our job is to get into the game and move the ball forward," said Guardino, quoting legendary Hewlett-Packard CEO David Packard. As President and CEO of the Silicon Valley Leadership Group, a public policy trade association of more than 390 Silicon Valley companies, Guardino seemed a little uncertain at first facing the crowd of environmentalists. But he soon warmed to his subject.

He acknowledged that projected flooding presented a significant threat to homes, businesses, and infrastructure at the water's edge, and noted that the South Bay seemed particularly vulnerable. He said a major storm could put hundreds of thousands of people and tens of billions of dollars in assets at risk, and directly impact what he called "the innovation economy." As he put it, "It's enlightened self interest to be mindful of the impacts without having to go through an experience like Hurricane Sandy. The Bay Area business community needs to engage, we can't wait for Sacramento or Washington." Guardino presented photos of mayhem in New York, and weak levees in the South Bay that would be no match for a Sandy-sized storm. He mentioned that wetlands help protect shoreline assets, and pledged support for shoreline protection efforts already underway through a new CEO task force. With a smile, he invited the audience to add their names to a "thank you partners" slide up on the big screen that was already crammed with logos. "There's no 'or' anymore between 'economy' and 'environment,' let me be clear," he closed.

The next speaker explored climate change uncertainties from a different perspective—that of a water supplier to nearly 2 million residents and businesses in the Silicon Valley. Linda J. LeZotte, a director at the Santa Clara Valley Water District, cited a state report identifying Santa Clara County, along with Los Angeles and Orange Counties, as having the highest potential for future flood damage in California. Some shoreline portions of the county lie as much as 13 feet below sea level, and others host residential subdivisions, urban zones, high-tech companies and the largest wastewater treatment facility in the Bay Area, she said. Most built shorelines are protected from the Bay by substandard levees or fledgling wetlands.

To address this risk, LeZotte said, the water district is working with the U.S. Army Corps of Engineers and the Coastal Conservancy on the South San Francisco Bay Shoreline Study. This congressionally authorized study is investigating the potential for flood risk management and ecosystem restoration improvements along the bayshore between Palo Alto and Milpitas. "At $125 million, this is not going to be cheap," said LeZotte. President Obama's budget includes the project, but the non-federal cost share is $56 million. The water district's Safe, Clean Water measure, passed in 2012, includes $15 million for its share of initial project construction, and another $5 million to conduct studies of additional areas.

Non-federal sponsors will make up the balance through credits derived from the value of the salt ponds.

LeZotte also detailed some challenges. For example, without authorization, the Army Corps is not allowed to do ecosystem restoration on lands owned by other federal agencies such as the US Fish & Wildlife Service, which controls much of the South Bay shore including salt ponds surrounding the town of Alviso. "Alviso is a priority—we need to replace non-engineered levees before a disaster happens," she said.

After the opening talks, the conference moved on to a panel of representatives from federal, state and local entities. Panelists made brief introductory remarks to get things rolling and audience inspire questions about regional wetlands restoration and flood protection challenges. Save the Bay's David Lewis started by urging the public at large not to take the Bay for granted. "We live in a very wealthy region—we have a public that cares and a public with resources. I hope the new SF Bay Restoration Authority [can channel some of this local wealth into our shoreline projects], because the Bay is not getting a fair share of federal resources compared with other estuaries," he said.

After Lewis, City of San Jose Environmental Services Director Kerrie Romanow described how San Jose is spending $700 million to rebuild the region's largest regional wastewater treatment facility to better serve 1.6 million South Bay residents and protect the health of the estuary. "After rebuilding it, we really want to make sure sea level rise doesn't put it underwater," she said, which is partly why San Jose has been investing in a buffering wetland on a nearby salt pond. Next, State Coastal Conservancy Director Sam Schuchat said he was looking forward to reintroducing Bay waters to the massive restoration site at the former Hamilton Army Airfield sometime next year. "This is [one of the prizes of our success] in piecing together funding from so many different sources," he said. In the future, he hopes the Restoration Authority, with a per-parcel tax of not more than $10, will create a more stable mechanism for collecting funding for wetland restoration, flood control and water quality projects. "We need all your time and all your money to make this happen," he said looking right at the audience with a smile.

Panelist Lieutenant Colonel John Baker, District Engineer for the US Army Corps, ended the panel's introductory remarks by pointing out that few people know the Corps has been involved in the security and safety of the nation's waterways for more than 200 years. The audience had many questions for the panel. Asked where "the big opportunities" are for strong climate change adaptation, David Lewis had a quick answer: "Where imminent restoration abuts infrastructure, like the wetlands around Facebook headquarters and Highway 84." Romanow suggested areas around wastewater treatment facilities, and Schuchat the Hayward Shoreline. "Every marathon starts with a mile. We have to identify places where we can have small victories, [obvious] win-wins," said Baker.

Another question concerned progress on a regional adaptation strategy on sea level rise. "There isn't one," said Schuchat. "But there is an evolving consensus about using natural solutions where we can. Where we can't, we're probably going to have to build some big honking levees." While having a regionally coordinated strategy would be desirable, Lewis felt it was unlikely that anyone could get nine different counties to agree on what that might be. "It's better to work with particular cities interested in setting a high bar for others

to match," he said. For Baker, however, piecemeal action might prove problematic. "Without a regional strategy, it is more difficult for an area to be prioritized by federal government for Corps involvement."

In a third question, someone asked for more details about the 2014 regional ballot measure that would fund the San Francisco Bay Restoration Authority. Schuchat said a proposed parcel tax on the ballot could provide $15 million over ten years for the Authority. "A million here, a million there, and we're talking real money," said Schuchat. Santa Clara voters have already approved $20 million for South Bay shoreline flooding projects, said LeZotte. Lewis added that the region still needs to make a better case for more federal funds to come to San Francisco Bay. Baker reminded the audience that the federal government doesn't have such deep pockets anymore. He said the Corps has to tackle a $60 billion backlog in harbor and waterway maintenance projects nationwide with a 2014 budget projected at just $4.7 billion. One thing needed to free up federal funding, he said, is to convince regulators to be more flexible with what the region does with dredged sediment. Once a waste product, dredged material is now a precious resource in the fight to keep shorelines abreast of sea level rise. "We've had some success pairing navigation projects that create mud with restoration projects that need mud," said Baker.

Sediment may be a scarce resource, but so is horizontal space needed for wetlands to move inland and buffer developed areas, the topic of another question for the panel. One way to get more space would be to expand offshore rather than onshore, and create wetlands in areas that are now open water, said Schuchat. "But that would require substantial and controversial changes in BCDC 'no-fill' policies," he said. Another way is to buy out willing sellers in the flood zone, which New York has been doing post-Sandy. "If there's no room for horizontal levees, then they have to go vertical," said the Corps' Baker. "But you don't keep building in a place that keeps flooding. I come from Texas, and even there that's the definition of insanity—doing the same thing over and over and hoping for better outcome," he said to a round of hearty applause.

The final question for the panel was whether state and federal regulatory processes help or hinder planning for sea level rise. San Jose's Kerrie Romanow said both were true. "In some ways they're providing planning assistance. In others they're getting in way with challenging requirements. But we find when we spend face-to-face time with them, we [manage] to achieve our goals together," she said. One longstanding regulatory tool may no longer be relevant. "Single species restoration is brain dead in the era of climate change," said Schuchat. Traditional flood protection regulations and approaches also need an overhaul as the sea laps ever higher on our shores, and extreme storms pour more water faster through our watersheds. Santa Clara's water district is already in the swim: "We don't build concrete channels any more," said LeZotte. "When feasible we remove them. The day of concrete channeling streams is over."

Be The Street

Nick Laurrell was living in Costa Rica and promoting online gambling with his Internet and crowd-sourcing skills before he got a gig leading Bay Area anti-litter campaigns. "I use my black magic for white magic purposes," said Laurrell at the conference. Rather than producing his own PSAs, he invited 14- to 20-year-olds to create and submit their own videos to his "Be the Street" contest. Laurrell targeted this demographic because statistics suggest that young people disproportionately contribute to the littering problem. More than 51 videos were submitted. "We got awful ones and we got great ones, but it was not about the quality of the videos, it was about the quality of the participants," said Laurrell.

Wednesday Plenary 1:

One Estuary, Many Plans

By Chris Austin

Delta Policy, Interagency Coordination, Drought

We're seeing much more state-led activity on the Delta than we've seen in decades," began Felicia Marcus, Chair of the State Water Board, as she opened the plenary session on the second day. "It really is heartwarming to see the leadership happening at the state level through two governors, and to see the legislature and the agencies engaging."
The coming year looks to be a critical one for the Delta, with the first Delta Plan starting its implementation phase, the Bay Delta Conservation Plan (BDCP) in the final stages of development, and the update to the Bay Delta Water Quality Control Plan underway, not to mention numerous other smaller programs in various stages of progress. How all of these plans and the people who implement them will mesh brought state agency leaders together with conference attendees for the panel discussion.

The impetus behind this attention to the Delta began with the landmark 2009 Delta Reform Act, which made the coequal goals of restoring the Delta's ecosystem and providing a reliable water supply overarching state policy. The Act also specified that achieving the coequal goals must be done in a manner that respects the Delta as an evolving place. In order to facilitate coordination across the numerous state and local entities with responsibilities in the Delta, the Act established the Delta Stewardship Council, charging it with developing a long-term management plan for the Delta and its resources. The Council's first Delta Plan went into effect in September 2013.

Chris Knopp, Executive Officer of the Delta Stewardship Council, explained that the purpose of the Council and the Delta Plan is twofold: to integrate the actions and plans of multiple agencies, and to create a new form of governance that not only facilitates this integration, but also establishes an adaptive structure for science, and creates a new form of accountability by establishing performance measures related to interagency accomplishments. A committee is being convened that will bring together the leaders of local, state and federal agencies to coordinate implementation of the Plan's 14 regulatory policies and 73 recommendations. "Balance is going to be an absolutely essential item of coordination among these plans," said Chris Knopp. In order to break the current deadlock on Delta management, he said, participants must place the coequal goals above their own individual interests and trust that achieving a balance will result in the outcomes everyone desires. "Stakeholders need to remember that balance is the objective," Knopp said. "But in the end, action is the requirement."

Chuck Bonham, Director of the Department of Fish and Wildlife, followed by saying while the number of individual plans and proceedings underway in the Delta is astounding, it's not as much about the quantity of effort underway but more about how to manage through the thicket of programs. "Relationships matter," he emphasized. "At the end of the day, my relationship with Felicia or Mark or Chris or Mr. Machado and how we want to solve problems may be more important than our individual turf or actual proceedings."

Mark Cowin, Director of the Department of Water Resources, agreed with Bonham's remarks, adding, "The big question is, how are these plans all going to fit together? At the end of the day, these plans aren't going to fit together because of perfectly crafted legislative guidance or our sparkling personalities, but because we're going to be motivated to make them work together for a common good." Cowin said that one of the biggest signs of hope for changing course in the Delta is the Collaborative Science and Adaptive Management Program (CSAMP). CSAMP aims to stem the tide of litigation by establishing a collaborative approach towards water project operation decisions in the Delta. Carrying this collaboration forward to the BDCP is the next step and the ultimate integration of our efforts, he noted.

The BDCP is the Brown administration's 50-year plan to secure state water supplies exported from the Delta. To get there, the plan proposes building new conveyance facilities to route water from the north Delta to the existing facilities in the south, while also restoring or protecting over 100,000 acres of habitat for native species. The core strategy of the BDCP is to recover populations of endangered species by both reducing reverse flows that under the current south Delta pumping regime harm salmon, and creating habitat for fish. At that point, the rules that control project operations could be stabilized, "providing a sustainable, foundational amount of water supply for those two-thirds of Californians that depend upon Delta water deliveries," Cowin said. "It's pretty simple in concept but very difficult to craft the plan."

Cowin cautioned, however, that the BDCP won't solve all of California's water problems by itself. Rather, it has to be part of a strategy known as Integrated Regional Water Management, which brings together local and regional agencies and organizations to develop projects that increase regional water supplies. Over the past ten years, DWR has provided $1.4 billion in grants to seed such projects. These funds have leveraged another $3.7 billion in local investments, resulting in hundreds of local projects that have reduced demand or added an estimated 2 million acre-feet per year to available supplies through recycling, actively managing groundwater as an underground reservoir, capturing storm water, and other means. "I really do believe this evolution towards Integrated Water Management is one of the most significant advancements in California water policy over the last couple of decades," Cowin said.

By contrast, Mike Machado, immediate past executive director of the Delta Protection Commission, was highly skeptical of the Delta Reform Act and the BDCP. The Commission is charged with protecting the Delta's overall environment, including its agriculture, habitat, and recreational values, and has gone on the record as being opposed to the BDCP. Often lost in the pursuit of the coequal goals, Machado says, are the objectives specified in the language of the Act. The objectives include protecting and enhancing the unique cultural, recreation, and agricultural values of the Delta as an evolving place, and restoring the ecosystem, including its fisheries and wildlife, as the heart of a healthy estuary. Furthermore, the safeguards established in the water code were meant to protect areas of origin and the Delta have not always been met. The diversion of water through an isolated facility in the north Delta, Machado argued, is contrary to the concept of the "common pool" as described in the water code.

"[Where does all the] mistrust and opposition to the plan being set forth to fix the Delta [come from]? It is the failed promises of exporting water surplus to the needs of the Delta watershed from a common pool. It is the threats to the area of origin. It is hysteria over levee failure and the potential abandonment of Delta levees with an isolated facility. It is the loss of 100,000 acres of farmland for habitat, the loss of legacy farms and the effects on the Delta and its communities from the disruption of habitat from over ten years of construction of the tunnels," Machado said.

Moderator Marcus followed with an explanation of how the State Water Board fits into the process. The Delta Reform Act details specific tasks for the board, including setting flow criteria for the Delta and updating the Bay Delta Water Quality Control Plan. The update to the water quality control plan will hopefully be completed by 2016, although the subsequent plan of implementation is an adjudicatory process that could take years, Marcus said. The State Water Board has been actively following the development of the BDCP and engaging in reviews of the draft documents. The Delta Reform Act also mandated that construction on the BDCP cannot begin until the Board approves adding the additional point of diversion. This water rights permit process also will require an adjudicatory, evidentiary hearing, Marcus said, a task involving a "cast of thousands." The State Water Board is also participating in the Delta Stewardship Council interagency committee charged with implementing the Delta Plan. In addition to all of this, the governor's office is working on a statewide California Water Action Plan that will define the administration's priorities over the next five years. All of this adds up to more coordination and collaboration on the Delta than ever before. "What I'm fond of saying is that it's about belts, suspenders, and flying monkeys—whatever it takes to get the job done," she said.

During the question and answer period, panelists were asked how climate change factors into their plans. "Climate change is the big game changer," replied Cowin. "It drives home the point that the status quo can't be depended upon." Knopp agreed, pointing out that significant environmental shifts are already apparent. "If we're not looking at this in a more holistic way, I think it's going to be very difficult to achieve a realistic balance." Machado pointed out that our water system is predicated on what we thought the world was like when we built the infrastructure, but that we're going to have to adapt to a new reality. "We have a limited amount of water molecules available in this state. So what we have to do is define what molecules are available, and then determine how you live within it, not create a greater demand, and with that demand, demand more water to meet it."

"We're scared to death at our department" of the shifts to come with climate change, responded Fish and Wildlife's Bonham. "What I'd ask everybody to do is take a deep breath and force yourself to rethink anything and everything you're ever thought about the Delta. Understand that we need to stop arguing about who it matters to the most and understand it matters to all of us."

Wednesday, Plenary II:

Tracking Next Generation Pollutants

By Ariel Rubissow Okamoto

Nutrients, CECs, Safer Consumer Products, Environmental Awards

"Without data, we wouldn't have much to say about the State of the Estuary," said James Cloern, as he kicked off the second session of Wednesday's morning plenaries on water quality. After thirty years of watching the ups and downs in the data streams coming in from various monitors in the Estuary, this US Geological Survey senior scientist is an avid proponent of public investment in collecting data on the water, in the water, over decades, and on a regular basis. His newest conclusion, after reviewing the latest trends in phytoplankton biomass and suspended sediment concentrations, is that the Bay's historic resistance to nutrient pollution is weakening.

"The Estuary's resistance comes from strong tides, high turbidity, and fast grazing [of algal blooms] by clams, but I've seen four signs that the Bay could now be on a trajectory toward the kinds of impairments seen in other nutrient-rich estuaries," said Cloern. Cloern showed slides of "dead zones" in East Coast estuaries by way of example. He explained that many estuaries have been enriched with nutrients derived from fertilizer runoff, fossil fuel combustion, and sewage discharge. Nutrient enrichment promotes fast production of phytoplankton biomass, he said, and in places such as Long Island Sound and Chesapeake Bay the metabolism of that biomass depletes oxygen from water and creates dead zones devoid of fish and shellfish. Research shows that San Francisco Bay receives higher nutrient loads than these estuaries, primarily from river inputs to the North Bay and treated sewage in South Bay, yet it does not suffer from high phytoplankton biomass or low oxygen because it has attributes that give resistance.

Following the data record, however, Cloern detected the first signs of weakening resistance in the South Bay starting in 1999. He noted a decline in clam abundance, a red tide in 2004, the presence of new harmful species in the phytoplankton community, and a significant jump in phytoplankton biomass. Where blooms mainly used to occur only in spring, Cloern and his team have more recently been recording these events in summer and autumn, too. "These kinds of events always occur during heat waves with calm winds. Waters mix very slowly, leading to exceptional blooms, and sometimes to red tides," he said, showing pictures of crimson algae clouding grey waters off the side of the USGS research vessel *Polaris*.

Despite the rise in blooms, and the presence of plankton species that can be toxic if consumed by clams and fish, Cloern said he'd seen no evidence of associated fish mortality in San Francisco Bay so far.

But alarm bells are ringing based on these kinds of observations. The San Francisco Bay Regional Water Quality Control Board is now developing a nutrient strategy for the Bay in partnership with the Regional Monitoring Program, wastewater dischargers, and the scientific community. "Much is at stake because the capital costs of nutrient removal could be $5-10 billion," said Cloern, referring to the increased levels of wastewater treatment and

pollution prevention required to tackle the problem. Other factors planners may need to keep in mind in developing the strategy are the opening of large new areas of salt ponds to tidal action, some of which could be incubators of harmful species of phytoplankton. Changes in ocean conditions also should be considered. "San Francisco Bay is connected to the shelf waters outside the Golden Gate where upwelling occurs, so the ocean can be a source of phytoplankton coming into the Bay," he said. "The Estuary is in a continual state of evolution, and there is great uncertainty about how the future will unfold," Cloern concluded.

Nutrients aren't the only unknown worrying those monitoring water quality and ecosystem health in the San Francisco Estuary. A whole suite of chemicals now being used in homes, businesses, industries and farms today aren't yet even possible to detect, let alone plan for or prevent from entering the estuary. The next speaker, Derek Muir, came all the way from Environment Canada in Toronto to explain why.

Muir, a senior research scientist, defines these chemicals of emerging concern (CECs) as any synthetic chemical that is not regulated or commonly monitored in the environment but that also has the potential to enter the environment and cause adverse ecological or human health impacts. He commended San Francisco Bay's Regional Monitoring Program for being one of the first on the continent to spotlight CECs, and guesstimated that globally there could be as many as 73 million known organic and inorganic substances, 19 million of which might actually be commercially available, 308,000 of which are inventoried and regulated, and only 500 of which might be routinely measured in environmental media (see slide).

"It's misleading to think everything on the list of known chemicals is actually in commerce," he said. For example, of the 73 million known chemicals on one list or another, only 30,000 are produced in quantities of more than one ton per year worldwide. The lists, and who compiles them, turn out to be important in getting a handle on the problem and prioritizing chemicals for more scrutiny. California and Oregon lead the world in making authoritative lists of safe or problematic chemicals.

Muir focused the rest of his talk on new tools for screening chemical safety. For example, a chemical's potential for persistence, bioaccumulation, biodegradability, and adverse effects can be assessed based on its molecular structure using widely available quantitative structure-activity relationships (QSARs). "Our computer models tell our chemists what to look for in terms of molecular structure," he said.

According to Muir, large lists of industrial organic chemicals, pesticides, and pharmaceuticals in Europe and the USA have already been screened and categorized by QSARs. These studies, as well as ongoing priority setting by chemical regulators in the US EPA, individual US states, Canada, the European Union, Japan and other countries suggest that about three percent of about 100,000 substances screened so far may be of concern. "Not everything worth measuring is measurable; nor is everything measured worth measuring," said Muir, quoting a US EPA maxim. "It's easy to get off on tangents. But what we have now is a convergence of information which will help us rule out some chemicals." Like every good scientist, Muir couched his words with caveats, pointing out that most screening exercises do not include the possible degradation products, byproducts, and

impurities of chemicals. He ticked off a number of other problems with current screening approaches, including the focus on registered chemicals. He also noted that many industrial chemicals may never be released into the environment, whereas many low volume personal care products like estrogen and antimicrobials, as well as pesticides, are regularly released into surface waters via wastewater or runoff.

The good news is that despite the challenges, there is a relatively large international effort to develop new tools for rapid screening of chemical toxicity, and to improve QSARs. "Screening can be successful if you have a tiered approach, good instrument technology, and good computer models," said Muir. (See also afternoon Water Quality session on CECs). The final speaker of the Wednesday plenary was Debbie Raphael, director of California's Department of Toxic Substances Control. She radiated pep and purpose from the podium, as she announced a new tool in the water quality toolbox: California's groundbreaking Safer Consumer Product Regulations, which went into effect in fall 2013. She also highlighted a new era of partnership, supported by Governor Jerry Brown, "who really pushes partnership," she said. According to Raphael, many voices contributed to the final form of the regulations over the five years since the underlying law was enacted.

The regulations identify 1,200 chemicals known to be problematic for human health or the environment. Many of the chemicals are contaminants of concern for California's water bodies, such as triclosan in personal care products, copper in marine paint, and coal tar in pavement sealants, to name just three. Using this list, the state Department of Toxic Substances Control is identifying specific "Priority Products" formulated using one or more of these chemicals, said Raphael. Manufacturers who wish to sell a "Priority Product" into California must either reformulate the product or justify the continued use of the chemical or chemicals of concern by submitting a robust Alternatives Analysis. "This is a powerful tool for public agencies and nonprofits trying to achieve source control of water contaminants," said Raphael.

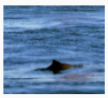
Raphael described the paradigm shift created by the alternatives analysis requirement and the mandate to avoid "regrettable substitutes," where a banned substance is replaced with an equally harmful one. "This regulation shifts the focus. Instead of asking, 'Is it legal to put this chemical in this carpet?,' the new questions are 'Is it safe? And is it necessary?'" The burden of proof is on the manufacturer. "Often the answer is 'no,' and often there are safer alternatives. We're not telling them how to design their product, we're just asking them to justify their design decisions," says Raphael.

In general, the regulations are set up in a way that allows affected industries and communities of concern to continue to weigh in. They're also designed so that water quality, and the health of California's aquatic ecosystems, are priorities. Products on the market in California have to meet special requirements, just as cars have to be more efficient and less polluting in the Golden State, among other groundbreaking examples. "So it's not about where it's made, it's about whether you want to sell it here," says Raphael.

Raphael's department plans to keep in close touch with water quality regulators about what chemicals or activities are giving them the most "heartburn." She wants to ensure the two state programs intersect. "When we look at the Bay, we see its beauty and how much we enjoy it, but we also know there's stuff in it we don't want in it. This little

safer consumer product regulation is really wanting to be at the table with you," she said, looking out at the audience of engineers, scientists, resource managers and regulators. Potential threats to the program on the horizon include resource limitations, lack of information on chemical hazards and exposure pathways, and pre-emption at the federal level. For the moment, however, there are signs that the marketplace is responding to the new initiative. Raphael recently saw an article on safer adhesives in *Floor Covering Weekly,* for example. "The world is watching," she said.

CONCURRENT SESSIONS



Porpoises Are In, Hybrid *Spartina* Out

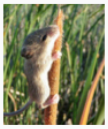
Decades of improved environmental stewardship are helping native wildlife flourish while keeping invasive species in check. READ ON

Engineering the Delta Marshes of Tomorrow

Climate change will force us to choose how wetlands from Suisun Marsh to the Yolo Bypass will function in the future. READ ON

Baylands Remodels Make Progress

All around the Bay, efforts to restore former salt ponds and infuse mudflats with new life are drawing native fish and fowl. READ ON



Mice and Sculpins Scope out New Habitat

Now that the bulldozers have departed, studies are revealing how landscapes are healing and wildlife uses newly restored habitat. READ ON

Intercepting Toxic Plastic Trash

The peaceniks of the Bay Area are waging war on trash. New studies show plastics can inject toxins into the food web, while bag bans are lessening the litter load on streets and creeks. READ ON

Restoring Water Quality with TMDLs

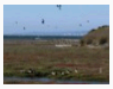
TMDLs (total maximum daily loads) are being integrated into toxic pesticide oversight of urban creeks of San Francisco Bay, the Central Valley, and the Delta. Meanwhile, TMDL controls on sediment runoff are aiding steelhead spawning in the Napa River. READ ON

Managing CECs: An Ounce of Prevention

The ever-increasing number of manufactured new chemicals, which include flame retardants and pharmaceuticals, often comes with little or no information on environmental risk. Such contaminants of emerging concern (CECs) are being found in local humans, seals and birds, sparking the development of regulatory and science guidelines to protect water quality. READ ON

More Nutrients, Less Sediment, New Water Quality Challanges

Since sewage treatment cleaned up the Bay, there have been few problematic algal blooms. But nutrient loads to the Bay are changing, and so are conditions. State efforts to develop water quality objectives and science plans are helping to quantify the Bay's daily nutrient allowance. COMING SOON!



Building Resilient Baylands

Understanding the historical context of local landforms and processes can inform efforts to provide for human needs while conserving ecological functions. The Baylands Goals Update will produce a vision for restoring and maintaining the ecological integrity of the Baylands over the next century. READ ON

Delta Economics and Ecosystem Management

Some consider the Bay Delta Conservation Plan a long-awaited chance to save the Delta's collapsing ecosystem; others view it as a ruinous boondoggle. Reconciling perspectives on this massive project will be critical to managing the distressed ecosystem of the Delta. READ ON

One Delta, One Science

The Delta Science Plan creates a framework for making scientific information relevant and available to decision makers. Here, scientists and agency managers discuss both the "grand challenges" that need to be addressed and how to get the most out of Delta science efforts. READ ON

Sharing Our Stories of the Estuary

San Francisco Bay and Delta have a rich human history. Stories from the Bay's indigenous inhabitants, builders of the Bay Bridge, and Delta communities are being shared via a new crop of museum exhibits, interpretive centers, and social media projects. READ ON

Scaling up from Reach to Region

Zoom in on a reach of the Napa River, and details that come to the fore are redds and hatchling habitat; zoom out to the watershed, and topics such as flood control and multi-city cooperation become important. Each of these scales contributes valuable information that can improve watershed management. READ ON

Porpoises Are In, Hybrid Spartina Out
By Joe Eaton

Species Status, Clapper Rails, Invasive Mussels

Years of efforts to help endangered wildlife recover and keep exotics out are paying off, according to speakers at Tuesday afternoon's session on the status of native and invasive species. Pipe-clogging mussels have made incursions but are being held in check. Weed warriors have made progress in clearing San Francisco Bay's mudflats of invasive spartina. On the endangered species front, California clapper rail populations appear to be holding their own. And the audience was reminded that nature's surprises aren't always unpleasant: after decades of absence, a highly visible marine mammal has returned on its own to the Bay. Harbor porpoises (*Phocoena phocoena*) were once common here, explained William Keener of Golden Gate Cetacean Research. Their bones were found in Emeryville's ancient shellmound. But these cetaceans abandoned the Bay about 65 years ago, after the construction of the bridges and Treasure Island and the installation of a wartime anti-submarine net. Only in 2008 did boaters begin sighting the five-foot-long marine mammals again. The National Marine Fisheries Service estimates a local population of 3,000. Keener and his team have been able to identify 600 individuals by their markings (one is all white, a miniature Moby Dick) and scars. The porpoises gather where high-energy tidal rips concentrate fish, making the Golden Gate Bridge's pedestrian walkway a prime place to observe them at high tide. "If you spend too much time there watching porpoises, you'll get the bridge patrol coming over to ask how you're feeling," Keener said. Porpoise mating in the Bay also has been documented for the first time. (The gonads of a breeding male outweigh his brain, and his courtship is unsubtle.) Observers haven't yet witnessed a local birth, although females have been accompanied by calves. Keener has also documented previously unsuspected commensal associations between dolphins and seabirds. Bottle-nosed dolphins (*Tursiops truncatus*), historically unrecorded in the Bay, have also moved in, feeding on salmon. They stay closer to shore than the porpoises; last year a couple briefly got stuck in the mud near San Francisco International Airport. One dolphin with distinctive fin notches spotted in the Bay was resighted off Ensenada. Keener sees the return of the porpoise and the dolphin colonization as signs of success in cleaning up the Bay: "The fish population in the Central Bay is doing pretty well. A healthy Bay will get predators coming in."

Although they abandoned the Bay, harbor porpoises were never at risk of extinction. The California clapper rail (*Rallus longirostris obsoletus*) was less fortunate. Habitat loss, hunting, and non-native predators reduced its San Francisco Bay population to a perilously low level and extirpated it from other Central Coast marshes. Since its listing as endangered, the rail's progress toward recovery has been uneven. Yet Julian Wood of Point Blue Conservation Science (formerly PRBO) expressed optimism about the bird's future. "The clapper rail is continuing to rebound," he said. "There was a drop in 2008. We don't know exactly what caused it, but it was a Bay-wide effect." By then, rails had begun using invasive hybrid cordgrass (*Spartina alterniflora* × *foliosa*) as habitat: "Part of the decline could be explained by the removal of spartina, but not the whole thing. There was no significant removal in the North Bay." The apparent decrease in rails documented in 2013 may be an artifact of reduced survey coverage in the North Bay. The best current population estimate is under 2,000. The birds still face daunting threats: predation by feral and domestic cats, native

raptors, and others; habitat degradation by invasive plants; contaminants and toxic spills; and a future likely to bring rising sea levels and extreme weather events. "Marsh restoration is critical for their survival and the best hope for recovery," Wood continued. The birds will colonize restored tidal marshes, as they've done at Faber Marsh in Palo Alto and Carl's Marsh in Sonoma County. Surveys from 2005 through 2013 indicate the rails do best in large marshes of at least 150 hectares that are compact rather than narrow or fragmented and have good structural diversity. He cautioned that the welfare of clapper rails was only one factor in formulating restoration strategies: "We should be making decisions that consider multiple species. It's not always easy." Point Blue's conservation priority map addresses a whole suite of marsh bird species under a range of sea level and sediment scenarios.

Reporting for the California Coastal Conservancy's Invasive Spartina Project, Drew Kerr recapped the campaign to eradicate the hybrid superweed. The hybrid can exploit more ecological niches than either parent species, and its enhanced pollen and seed production help it swamp competitors. As of 2012, the infestation had been reduced from a maximum of 809 acres in 2005 to just 39 acres as of 2012. Native plants like perennial pickleweed (*Sarcocornia pacifica*) have resurged on their own where the hybrid has been removed, mudflat has been reclaimed for foraging shorebirds, and waterfowl and fish spawning habitats have been preserved. But it's too soon to declare victory. "Restoration programs are at great risk of invasion," Kerr warned. "Every tidal marsh project over the last 25 years has been invaded and/or dominated by hybrid spartina." Ten East Bay sites occupied by clapper rails remain off-limits for treatment under the current Biological Opinion, which Kerr said has resulted in a slowdown in acreage reduction. Hybrids in untreated marshes have the potential to export seed to areas that are currently spartina-free. Regarding the rail population swings Wood described, Kerr said, "Those impacts are in the past at this point. Things have stabilized out over four years of rail monitoring." ISP is now emphasizing the propagation and planting of native spartina (*S. foliosa*), Pacific gumplant (*Grindelia stricta*), and other indigenous marsh plants adjacent to hybrid infestations where future treatment is anticipated: "The goal is to enhance marshes around the treatment sites to provide a safety valve for the clapper rails." Seed suppression with a dilute herbicide solution is also being field-tested at a Bair Island site. "Managing the risk of proceeding with tidal marsh restoration will allow us to move forward," Kerr concluded.

Feared invasions by shellfish appear to have been nipped in the bud, reported Martha Volkoff of the California Department of Fish and Wildlife. The 2007 discovery of quagga mussels (*Dreissena bugensis*) in California waters tripped the alarm. Its relative the zebra mussel (*D. polymorpha*) showed up the following year. Native to the Black Sea, these tiny but prolific mollusks crossed the Atlantic in ship ballast water and colonized the Great Lakes. They can also hitchhike cross-country on boat hulls. That's likely how they reached Lake Mead, their jumping-off point for the lower Colorado River. Zebras and quaggas clog underwater pipes and screens, consume food that native species need, and impair water quality. Their presence could have a major impact on the state's water conveyance system. "We were acutely aware they were bad news," Volkoff recalled. "But it was hard to plan for a potential threat while already dealing with existing threats." Fish and Wildlife's Incident Command System, partnering with the state Water Resources and Food and Agriculture agencies, swung into action, surveying potentially infested water bodies and developing regulations to contain and control the mussels. "It was clear early on that state agencies couldn't shoulder the entire responsibility," she added. "They would have to play an advisory

role to local agencies." All but one of the state's 25 infested reservoirs now have control plans in place. Boat inspections at the state line are a key piece of the strategy; so far, 499 vessels with mussels attached have been intercepted and quarantined. Outreach to the fishing and boating communities has included fliers, a web site, and a YouTube video. "Our biggest claim of accomplishment is that there's been no known overland spread as the result of boats," Volkoff said. "We feel our work with the public has been effective." But challenges remain. Funding is tight, and California has much vulnerable freshwater habitat to protect.

Engineering the Delta Marshes of Tomorrow

By Victoria Schlesinger

Fish Habitat, North Delta Arc, Suisun Marsh Scenarios, Yolo Bypass

The curving swath of waterways and marshes that stretches from Suisun Marsh, northeast up the Sacramento River—referred to by presenters on Tuesday afternoon as the North Delta Arc—are prime spawning, growing, and foraging habitat for native estuarine and freshwater fish. Yet fish as well as waterfowl in the area will face challenges as sea level rises, other effects of climate change take hold, and people continue to modify the region. Three presenters from UC Davis's Center for Watershed Sciences looked ahead at how to best support the region's ecosystem in the decades to come.

Research led by John Durand with UC Davis has examined what makes the North Delta Arc—including Cache and Lindsey sloughs and Suisun Marsh—successful habitat for fish. Their preliminary research identified several mechanisms critical to supporting resiliency in the region's ecosystem, including habitat complexity, tidal interaction with the shore, water quality dynamics, and interconnected habitats. They described the North Delta Arc as a mosaic of riparian habitat, mudflats, rip-rapped levees, tule stands, and emergent vegetation bathed in highly variable tides. Tidal exchange of sediment and phytoplankton in the water help maintain a variety of habitats that may be beneficial to both native and desirable invasive species. The researchers noted that phytoplankton growth appears to be most concentrated in the upper reaches of dead-end sloughs, possibly contributing to the local food web. Because these sloughs are well connected to the main channels of the estuary, aquatic life can readily move between them in search of food or refuge. UC Davis researchers aim to learn how these aspects of the ecosystem function in order to inform plans for tidal marsh restorations throughout the Delta said Denise Decarion, a project collaborator who presented on behalf of Durand.

Integral to the North Delta Arc's past and future is historic Suisun Marsh—the largest remaining estuarine tidal marsh on the West Coast. Presenter Amber Manfree, coeditor of the forthcoming book "Suisun Marsh—Ecological History and Possible Futures," outlined different approaches for managing the wetlands. Nearly all of the marsh has been affected over the past 100 years by the construction of dikes, canals, roads, floodgates, and upstream diversions. For this reason, Manfree said, heavy human intervention is required to maintain the current state of the marsh. Pressures from sea level rise and changing precipitation patterns will demand new approaches to managing the marsh over the coming century. According to one model, the 100-centimeter rise in sea level

anticipated by 2100 could render most of Suisun Marsh a subtidal zone. The marsh could be preserved as it is today with the same goals as the Suisun Marsh Plan—maintaining current levels of duck hunting, open space, recreation, endangered species protection, and urban area buffers from sea level rise. This would require traditional levees with tidal gates to keep the rising waters literally "at bay." But over time, the amount of diking required to maintain such a "fortress marsh" would likely become financially unsustainable. Another future could be a flooded marsh, which would ensue if any of the dikes breached in an earthquake or extreme storm. Such an event would transform much of the marsh into tidal or sub-tidal habitat. But if soil-building processes could keep pace with the rising sea level, tidal marsh habitats would eventually develop. A third option would be to manage the area as a tidal marsh, with diverse habitats, and planned wildlife corridors. This would require significant funds for conservation and limiting duck hunting activities. A final option, which Manfree calls an "ecomarsh," would prioritize the needs of wildlife and employ every means to conserve habitat over the long term, including building up soil. "Addressing expected changes sooner than later," said Manfree, who is completing her PhD at UC Davis, "leaves more options open for us."

Some 40 miles upstream of Suisun Marsh lies the Yolo Bypass, which diverts floodwaters from the Sacramento River into the Sacramento-San Joaquin River Delta and ends near Cache Slough. As part of the Bay Delta Conservation Plan, the proposed Conservation Measure #2 would allow more floodwaters to reach the Bypass and adjacent Yolo and Solano counties. UC Davis's Robyn Suddeth has modeled the impacts of such increased flooding on regional agriculture, wildlife, and recreation. While critical for managing floodwaters, the bypass is important to aquatic species that migrate along the waterway. Chinook salmon and splittail find plentiful food here. Waterfowl and migrant birds stop here during their journey along the Pacific Flyway. Because the bypass already supports so much wildlife and covers such a large area, it is often pointed to as a rare place within the Bay Delta system with great potential for habitat restoration. Though extremely valuable to wildlife, the floodplain is equally prized by farmers. Rice is the primary crop, but this landscape is also used for grazing and to grow corn and tomatoes. Like Suisun Marsh, the bypass is popular among duck hunters, and contains a state wildlife area. But as flood patterns change, said Suddeth, the question is whether "it's possible to have an ecologically functioning flood plain that's also heavily engineered and managed." To help planners and decision makers answer this question, Suddeth has plugged expert surveys and numerous other data sources into her model. Her results indicate there will be trade-offs associated with different management scenarios. As an example, she showed how one could set the model to flood in a manner that would optimize habitat for fish or waterfowl, and what this might cost farmers in terms of yields and limits on crop choices.

Baylands Remodels Make Progress

By Joe Eaton

Salt Ponds Restoration, Hamilton, Eelgrass, Living Shorelines

Few restoration efforts anywhere rival the South Bay Salt Pond Project in scope, expense, or complexity. "We're celebrating the tenth anniversary this year," said Project Manager John Bourgeois, who heads the multi-agency collaboration. Bourgeois is responsible for transforming a Manhattan-sized expanse of former salt production ponds and other wetlands, much of it acquired from the Cargill Salt Company in 2003. Restoration here isn't just a matter of breaching the dikes and letting the Bay in. "There are tradeoffs," Bourgeois explained. "The salt ponds have been here for 150 years, and a suite of species has utilized them. In restoration, we're taking away habitat for certain species and giving it to others. On a landscape scale, we need to ensure we're not doing more harm than good." One example is the endangered snowy plover (*Charadrius nivosus*), which prefers to nest in the moonscapes of the salt pannes. Project scientists have also detected increased mercury concentrations in the eggs of fish-eating birds.

Adaptive management will be necessary as the process advances. "At minimum, the goal is to get to 50 percent tidal marsh," Bourgeois added, although the ultimate proportion could be as high as 90 percent. "In Phase 1 we picked the low-hanging fruit and got some of the easy projects done: taking down levees, letting natural processes back in. We've been pretty successful so far; the sedimentation rate is exceeding expectations, and the revegetation rate has been rapid." Eight of nine Phase 1 projects have been completed. "We're doing certain things that don't look like natural ecosystems, building in a robust capacity to manage water, and experimentally constructing nesting islands for birds." By next year, Bourgeois said, 3,750 acres will have been restored: "We're trying to move rapidly in the face of sea level rise and get as much tidal marsh restored as we can." To date, the project has cost $190 million, mostly allocated for land acquisition. "Funding will be a challenge moving forward," he acknowledged. "To get from here to 50 percent tidal marsh, we need money. To get to 90 percent, we need money and science. We need to understand more about sediment dynamics and how wildlife uses the restored areas. With state bond money and federal appropriations drying up, we need new sources, especially to fund the science program."

In the North Bay, meanwhile, the Department of Fish and Wildlife, Ducks Unlimited (DU), and other government, nonprofit, and private-sector partners have been engaged in another ambitious project. "It's been called a national model for restoration," said DU's Renee Spenst. Restoration efforts began when the state acquired nearly 10,000 acres of former Cargill salt production ponds in Napa and Sonoma counties in the early 1990s. To date, 5,000 acres have been restored, another 2,000 enhanced. Challenges included handling the concentrated brine at the 1,360-acre Napa Plant Site, the thick salt crust on crystallizer beds, land subsidence, and the need to work around existing infrastructure such as Highway 37, railroad and power lines. Work on the Napa Plant Site culminated in 2010 with the South Unit breach. Spenst reported gratifying responses from wildlife. "The Plant Site is now excellent habitat for ducks," she said. Shorebirds flocked to the restored ponds, and the endangered California least tern (*Sterna antillarium browni*) began nesting in 2009.

Chinook salmon (*Oncorhynchus tshawytscha*), steelhead (*O. mykiss*), and Sacramento splittail (*Pogonichthys macrolepidotus*) are also using the new habitat: "It's surprising how quickly fish are coming into the site." Uncertainties remain, notably funding. "Monitoring is a continued challenge—how to monitor meaningfully, feeding back into the project as we move forward," Spenst noted. She also stressed the need to connect areas of good wetland habitat, provide upland space that will enhance resilience to sea level rise, and develop better incentives for reusing sediment.

While engineers contended with toxic brine in Napa, those working on Hamilton Field wrestled with tarmac. "We left the runway in place and put mud on top of it," said Tom Gandesbery of the California Coastal Conservancy, the sponsoring agency. "It would have been too expensive to remove." As it was, converting the former military air base into a wetland took "money, time, and a lot of hard work." After being diked, drained, farmed, and used as an airfield, the site had subsided six feet below sea level. Fixing that provided a showcase for the beneficial reuse of dredged material under the Long Term Management Strategy. The US Army Corps of Engineers provided 5.6 million cubic yards of clean sediment from the deepening of Oakland Harbor, pumped to the site through a pipeline under San Pablo Bay from an electric powered offloader 5.5 miles offshore. "It was powered by the world's longest extension cord," Gandesbery joked. When completed next year with the breach of a bayside levee, Hamilton will feature tidal and seasonal wetlands, an upland transition zone, and wildlife migration corridors. The Coastal Conservancy is also building 2.7 miles of public trail at Hamilton, a future segment of the Bay Trail system. An on-site nursery grows native plants destined for the seasonal wetlands and transition zone. Some have been put into the ground already by volunteers: "It's a great way to get the local community to take ownership of the project," Gandesbery said. Next, the Conservancy will take on Bel Marin Keys north of Hamilton, which will require a different approach. "There are many more restoration sites than we have mud for," Gandesbery explained. "With 2 million cubic yards per year dredged in the whole bay, there's not enough to go around. The Oakland deepening project is done and there are no other big projects on the horizon." One long-term solution may be stockpiling dredged material at an underwater drop-off spot, which would decouple offloading and pumping from the dredging process.

Scaling down from those three megaprojects, Katharyn Boyer of San Francisco State University's Romberg Tiburon Center described the work of the San Francisco Bay Living Shorelines Project at two smaller test sites. Her group is using two native species, Olympia oyster (*Ostrea lurida*) and eelgrass (*Zostera marina*), in experiments that may help restore lost ecological functions and build a more resilient Estuary. The Living Shorelines concept, which was pioneered on the East and Gulf Coasts, involves providing living spaces for organisms that will protect the shoreline from increased storm surge and other consequences of climate change. "Oysters create a heterogeneous reef space that allows other organisms to come. Eelgrass traps sediment, reduces erosion, sequesters carbon builds habitat and provides foraging areas for other organisms," Boyer said. Off San Rafael, Boyer installed a mix of oyster-only, eelgrass-only, combination, and control plots. Structures made out of "baycrete"—Portland cement mixed with oyster shell and sand—and shaped into reef balls, blocks that interlock "like Legos," provide settlement sites for planktonic oyster larvae, as do shell-bag mounds. At Eden Landing near Hayward, eelgrass collected at nearby sites has been planted and shell mounds created for the oysters. After a year, over 2 million oysters

have settled on the San Rafael mounds alone: "It's wall-to-wall oysters out there," Boyer said. Shellfish weren't the only species drawn to the settling surfaces; crabs, sea slugs, anadromous fish, and birds, including the locally uncommon black oystercatcher (*Haematopus bachmani*) showed up, too. "There's so much life on these reefs," Boyer said. Her team is also tracking changes in wave energy and sedimentation. At Eden Landing, oyster recruitment has been low, possibly impacted by the predatory Atlantic oyster drill snail (*Urosalpinx cinerea*), but eelgrass has established well. Both sites will be monitored through 2017.

Mice and Sculpins Scope out New Habitat

By Joe Eaton

Wildlife Responses to Restoration, Mice, Plovers, Terns, Fish

What happens once wetland structure and function has been restored? How quickly do birds, fish, and other creatures begin using the new habitat, and which species are first responders? How valid are our assumptions about which habitat types are best for focal species? Three speakers wrapped up the restoration session on Wednesday afternoon with considerations of those questions.

First up, Sarah Estrella of the California Department of Fish and Wildlife discussed the status of the northern salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes)* in Suisun Marsh. Listed as endangered since 1970, the rodent is "characterized by cuteness," reddish-brown fur, and a docile disposition. "In the past, there was thought to be a strong association between the mouse and pickleweed," she said. "Those of us working in the marsh suggested they were not so limited in habitat." A two-year mark-and-recapture study compared abundance, reproduction, and survival in pickleweed versus mixed vegetation (bulrush, fat hen, alkali heath, and others), and in tidal marsh versus diked wetlands. Among other results, harvest mouse densities were found to be higher in mixed vegetation than in pure pickleweed, at least in tidal areas, and higher in diked than in tidal marsh. However, tidal marshes did have higher post-winter survival. A more recent telemetry study challenged another assumption: "We had assumed they move up in elevation at high tide. Instead, they primarily remain in emergent vegetation over standing water when the tide comes in." Estrella noted that the draft US Fish & Wildlife Service recovery plan covering the mouse calls for extensive conversion of diked wetland to tidal: "Even though diked wetland supports higher densities, it's considered lower-quality habitat due to its artificial state. Additonally, many habitat models used in environmental documents fail to recognize the spectrum of vegetation types the mice thrive in." Her recommendation: "Habitat management efforts should include mixed vegetation types, both tidal and diked wetlands, and areas where sea level rise can be accommodated."

The most conspicuous inhabitants of wetlands, birds are easier to monitor than mice—and their responses can help reveal unintended consequences of restoration and inform adaptive management. Catherine Burns of the San Francisco Bay Bird Observatory reported on three studies of avian reactions to the South Bay Salt Pond Restoration Project. California gulls (*Larus californicus*), whose populations have increased exponentially in the South Bay, prey on the eggs and nestlings of other birds, including sensitive species. Burns reported that the breaching of Pond A6 in the Alviso complex displaced one of the largest

gull colonies. That eased predation pressure on a nearby colony of Forster's terns (*Sterna forsteri*), where chick survival increased. Snowy plovers (*Charadrius nivosus*) pose a different kind of management dilemma, since they nest on salt pannes that will be converted to tidal marsh. "The South Bay project aims to increase plover numbers while decreasing preferred breeding habitat, packing more of them into a smaller area," Burns explained. Plovers are also vulnerable to gulls and other predators. The good news: nests in experimental plots covered with oyster shells show higher survival rates. As for one downside of restoration, Burns reported that analysis of Forster's tern eggs confirm concerns that the process would mobilize mercury in pond sediments. From 2010 to 2011, mercury concentrations in tern eggs increased by an average 74 percent in restored ponds as compared with reference ponds, and exceeded toxicity thresholds 100 percent of the time. However, mercury levels in American avocet (*Recurvirostra americana*) eggs at the same sites did not change. "It's been challenging," she summed up. "We need to analyze the responses of a variety of waterbirds. It's not going to be easy to sort out all these responses. We're really learning a lot through monitoring."

The session's final speaker, UC Davis fish biologist James Hobbs, gave an update on how fish are using South Bay salt ponds that have been reconnected to the Bay. Bottom line: "The restored ponds are quickly used by fish"—and over 85 percent of the 30,000-plus fishes sampled were native species. Restoration has provided over 1,800 acres of new subtidal habitat. Since 2010, Hobbs and his crew have been surveying recently breached ponds at Bair Island, the Alviso/Coyote Slough complex, and Eden Landing, using trawls and hook-and-line angling. Numbers and diversity are highest at Alviso, the largest complex, and lowest at Eden Landing, breached only in 2010. Although the species mix varied among the sites, Pacific staghorn sculpins (*Leptocottus armatus*) were the most abundant in all three. Hobbs also reported seasonal changes in the species assemblage, with more pelagic types in winter. Overall, fish that can tolerate low dissolved oxygen are more abundant. The survey documented the highest abundance of mysid shrimp, the favored prey of the threatened longfin smelt (*Spirinchus thaleichthys*), in the Estuary. Leopard sharks (*Triakis semifasciata*) are visiting the Eden Landing pond: "The pond breaches serve as predator hotspots, which is good as long as the predators are native. Pond production is translating up the food chain, providing benefits to fish in the Bay."

Intercepting Toxic Plastic Trash

By Victoria Schlesinger

Capture, Gyres, Lanternfish, Stormwater, Bay Area Hot Spots, Bag Bans

Just months from now, significant trash reduction requirements will take effect around San Francisco Bay. The aim of the requirements is to keep refuse from local municipalities from entering the Estuary, and ultimately the ocean. In a Tuesday afternoon workshop, nine presenters detailed the Bay's troubles with trash. They covered subjects ranging from how garbage contaminates the food chain to what local cities and counties are doing to stem this pollution-laden tide.

Janet Cox, who directs the San Francisco Estuary Partnership's (SFEP) ambitious trash capture demonstration project, opened the session with highlights from the four-year run of the organization, which ended in November. With $4.2 million in funds, the project installed 4,003 trash capture devices in more than 60 municipalities through a partnership with cities, the San Francisco Bay Water Quality Control Board, the Bay Area Stormwater Management Agencies Association (BASMAA), and the State Water Resources Control Board's Division of Financial Assistance. The trash capture devices prevent litter from accumulating on Bay shorelines, and lingering indefinitely in our seas.

The trash that has already escaped into the ocean is being studied by 5Gyres, a nonprofit that conducts marine plastic pollution research and education. Since 2007, the organization has led 19 ocean voyages to the world's five main oceanic gyres, circular currents that collect and trap trash. Of the 424 gyre surface water samples the organization has collected, 99 percent contained plastic. "What we mainly see is a plastic soup—water with suspended plastic bits—and not a plastic island or patch, as the media usually describes it," said speaker Carolynn Box, an environmental coordinator for 5 Gyres. The organization aims to map the density and distribution of plastic particles within the gyres. In some instances they've documented as many as 400,000 particles of plastic per square kilometer. 5 Gyres will participate in multiple research projects in 2014, including partnering with the California Water Board and BASMAA to evaluate techniques to measure trash in storm drains, streams, and rivers, in San Francisco Bay and the Los Angeles region.

The Environmental Protection Agency's region 9 (Pacific Southwest) staff have studied how such bits of ocean plastic affect the health of marine life. Contaminants in water are pervasive worldwide. A study by Tokyo University concluded that many pollutants have a propensity to hyperaccumulate on plastic bits at concentrations 1,000 to 1 million times higher than in surrounding seawater. While marine animals are harmed when they eat plastics, scientists are now more concerned that plastics serve as vectors for toxic chemicals to enter the food chain. EPA region 9 staff, partnering with the state's Office of Environmental Health Hazard Assessment, tested this idea by analyzing the tissues of lanternfish (*Myctophidae*) for chemicals associated with plastics. This ubiquitous group of fishes is a common meal for other marine life. Lanternfish also eat zooplankton in the upper water column, where plastic particles and trash accumulate. In samples from all 280 fishes tested, the study found traces of one or more plastic chemicals including bisphenol A (BPA),

a common form of hard plastic; alkylphenols (AP), additives in plastics; and polybrominated diphenyl ethers (PBDEs), which are found in flame retardants.

The ability of plastics to dose fish with contaminants was supported by a second study conducted at UC Davis. Scientists compared the tissues of Japanese killifish, or medaka (*Oryzias latipes*) fed diets of fishmeal that were augmented with 10 percent virgin plastic, 10 percent marine contaminated plastic, or uncontaminated. Within two months, the fish in the marine plastics group showed higher levels of PBDEs, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs); the latter are both considered human carcinogens. When the group fed pure fishmeal also turned out to be contaminated, researchers learned that the high-quality fishmeal food contained cod liver oil, which is contaminated with PCBs. "There's a synergistic effect between common ocean pollutants and their transfer via plastic into marine life," said speaker Anna-Marie Cook, regional coordinator for EPA Region 9's marine debris program. "It's a toxic cocktail and a huge problem waiting for us to come up with answers."

Part of the solution is to limit the amount of trash reaching waterways. The Bay Area has taken an aggressive step in that direction. By June of 2014, all large municipalities in the Bay Area must cut the amount of trash entering local waterways by 40 percent. The new trash reduction requirements are a stipulation of the Municipal Regional Stormwater Permits issued by the San Francisco Bay Regional Water Quality Control Board. Cities must further reduce the volume of trash in stormwater by 70 percent in 2017 and 100 percent in 2022. Top of mind for everyone is how compliance will be measured. Speaker Dale Bowyer of the SF Bay Regional Water Board said identifying and monitoring the progress of areas that generate large amounts of trash will be crucial, as will on-land assessment of trash and, eventually, measurement of trash directly in water.

Speaker Chris Sommers with the engineering consulting firm EOA, Inc. analyzed 61 factors such as population demographics and land use as part of his analysis of the Bay Area's garbage problem. Sommers then created a trash-generation map which shows that the areas producing the most trash are residential and retail sections of low-income neighborhoods. The analysis determined that roughly 35 percent of the urban portion of the Bay Area likely needs attention, said Sommers. The other 64 percent of urban areas generate very low levels of trash and litter.

Oakland faces many of the challenges Sommers' described: 42 percent of its housing is high-density, 60 percent of its population are renters, and 18 percent of its residents live in poverty. The city has installed 12 capture devices, which resemble giant cylinders with mesh bottoms, in strategic areas such as catchment basins to capture runoff from a maximum number of acres. The >$2.9 million project collects water from 900 acres. Most of the devices are 25 feet underground and measure four feet in diameter and 19 feet deep. When the units are cleaned every six months, they have yielded up to 12 cubic yards of trash. Despite the large quantity of trash diverted from the Bay thus far, "we have a long way to go to [reach] 100 percent," said speaker Rebecca Tuden, a watershed specialist for the City of Oakland. A disadvantage of these units is that the trash capture is not visible to the community. Oakland is also looking at other trash reduction measures, too, such as street sweeping five days a week in high trash areas.

Plastic bag bans are another popular tool for achieving the mandatory trash reductions. Napp Fukuda, deputy director of San Jose's environmental services department, discussed the city's successful ban almost two years after its implementation. "As the third largest city in California, and with a population of almost a million," said Fukuda, "dealing with trash is a big challenge, but we also see it as an opportunity." The city's plastic bag ban affects 5,000 retail businesses and imposes a 10 cent fee for paper bags. Fukuda said his department has observed 98 percent compliance among businesses. In the meantime, the percentage of consumers bringing reusable bags increased from 4 percent to 62 percent, while 43 percent of shoppers now use no bag. The city has also observed a 59 percent decrease in street litter. San Jose's latest plastic-reduction step is a ban on styrofoam takeout containers. The ban goes into effect January 2014 for large multi-state restaurants, and a year later for all other restaurants.

In a similar effort, Alameda County implemented a plastic bag ban just under a year ago, requiring a 10-cent fee for paper bags and plastic reusable bags. The ordinance affects 1,500 businesses, including supermarkets, grocery, convenience, drug, and liquor stores. Stopwaste, the public agency dedicated to reducing the county's waste stream, is shepherding the effort. Presenter Meri Soll, a program manager with agency, said that initial anecdotal data is positive based on inspections of 250 stores.

Another city strategy—transforming a trash hotspot into a public good—was described by Rinta Perkins, stormwater program manager for the City of Walnut Creek. A section of the city's namesake waterway had become an illegal dumping ground and homeless encampment. With $400,000 of city and grant money, the city built a pedestrian path along the creek with signs describing the local habitat and advocating pollution prevention, as well as a pesticide-free demonstration garden. Volunteers conduct annual creek cleanups and remove invasive species. The effort has yielded a 68 percent reduction in trash in the area. With the help of partner organizations, more than 700 people and students have been educated about watershed stewardship through guided tours and outdoor watershed classrooms. "[At] what was once an abandoned site," said Perkins, "we now see people all over."

Restoring Water Quality with TMDLS

By Ariel Rubissow Okamoto

Pesticides, Sediment, Toxic Creeks, Water Boards, Napa County

When contaminants are coming from so many sources – whether it's farm fields or urban areas or eroding creek banks, not to mention drains and discharge pipes – balancing actions to curb them can be a daunting task for water quality watchdogs. To this end, however, the two regional water boards charged with protecting Central Valley waterways and San Francisco Bay from contamination have effectively wielded the "TMDL." This Clean Water Act tool allows the boards to set a total maximum daily load of a contaminant for an impaired water body, and to work with diverse sources to reduce the load collectively. Such efforts often inspire new regulations, and a suite of related outreach and prevention programs. In this afternoon session, speakers described their experiences managing two

priority contaminants – pesticides from agricultural irrigation upstream and urban creeks downstream, and sediment in the Napa River watershed.

First speaker Joe Karkoski, an engineer with the Central Valley Water Board, described how the Board adopted basin plan amendments to address diazinon and chlorpyrifos in the Sacramento, Feather, and San Joaquin Rivers, as well as the Delta, in the early 2000s. Those amendments included TMDL allocations, implementation provisions, and monitoring requirements for irrigated lands.

To be more specific, the Board set water quality objectives of 0.10 ug/L for diazinon and 0.015 ug/L for chlorpyrifos, and reached out to the Central Valley's 35,000 farmers to meet them. "We monitored, we assessed, we made regulations. But just having a regulation doesn't mean it gets implemented," said Karkoski. "It's not enough to create incentives, we also need new tools to get things done."

Using the tools available, the Board encouraged agricultural coalitions to take a variety of pollution prevention steps related to pesticides and erosion. These included switching from furrow or flood irrigation to drip irrigation and micro-sprinklers; building sedimentation ponds; and doing a better job of managing tailwater return systems. The Board also worked with the Department of Pesticide Regulation (DPR), which in turn created some new dormant spray regulations. Among other things, these required anyone spraying fruit trees during the dormant cool season to maintain100-foot buffer zones from waterways, and prohibited spraying during a storm. More importantly, if alternative pesticides are used, they can't cause a water quality problem, explained Karkoski.

Since 2004, there are far fewer exceedances of water quality objectives for the two pesticides, thanks to the program. But pyrethroids, their main replacement, now exceed objectives for water 40-50 percent of the time, and can be just as toxic to some aquatic organisms. "You can spend a lot of time in the weeds monitoring, but what we really need is to spend more time anticipating," said Karkoski. "If you stop paying attention, problems are probably going to reoccur. We need to deal with not only particular contaminants, but also with pollutant pathways, and figure out how to sustain positive results."

The second speaker tackled the same pesticide problems but on a more urbanized landscape. The alarm bells went off when monitoring revealed widespread toxicity in 35 urban creeks in the Bay Area, results replicated around California, explained Kelly Moran of TDC Environmental. In the 1990s, they pinpointed the cause of this toxicity: diazinon.

Manufacturers agreed with U.S. EPA to end sales of all urban products in 2004, and diazinon use plummeted in Sacramento and the Bay Area. "Diazinon in our creeks dropped to zero three years after the ban," said Moran. Various pyrethroids replaced diazinon as the active ingredient in many urban pesticide products. "Unfortunately we just traded one type of toxicity for another." Indeed, Bay Area use of pyrethroids tripled in four years, and toxicity climbed again.

The San Francisco Water Board, with Moran's help, was ahead of the game. In crafting its 2005 TMDL for diazinon, it recognized that there was a general problem with

pesticides and built in a more big picture approach. "This was not a traditional TMDL. This TMDL addresses future pesticide related toxicity, and promotes integrated pest management," said Moran.

"It's not about lawn and garden pesticides, it's about pesticides used around buildings, much of which are sprayed in urban areas on impervious surfaces, " said Moran. And the main reason city dwellers are using pesticides is not to control fleas or mosquitos or termites, but to control something much more harmless: ants.

Concerned about the water quality impacts of all this spraying, the TMDL team suggested that DPR consider actions to reduce pyrethroids in runoff. At the time, product labels directed users to apply pesticides in a 10-foot wide spray zone around buildings to prevent ants. DPR determined to restrict the spray zone on pyrethroids to two feet, rather than 10, which is just as effective.

DPR also broadened its view on new product registration. "The big fix has been getting DPR to ask a question it never asked before: will this product cause water pollution?" said Moran. On the federal level, EPA has also improved its pesticide review process.

Indeed this "untraditional" pesticide TMDL has led to landmark changes, said Moran, including California regulations coupled with special restrictions placed on bifenthrin (the most environmentally persistent pyrethroid) that are together expected to reduce pyrethroid-caused toxicity by 80-90 percent.

"We built a team that coordinated water quality and pesticide regulation for the first time, and included wastewater and stormwater dischargers. All it takes is a good structure, a good plan, and education," concluded Moran.

Education also featured strongly in the Napa County Resource Conservation District's efforts to curb sediment pollution to the Napa River, according to the third speaker Leigh Sharp. Expansion of vineyard development from the valley floor to the hillsides was common in the late 1980s and increased erosion. In the early 90s, facing declines in salmon and steelhead and a threat to aquatic habitat, the regional water board listed the Napa River and its tributaries as water quality impaired for excessive sedimentation. The problem even made the news when sediment from a newly developing vineyard slid into St. Helena's drinking water supply. "You can't use the same erosion control practices on hillsides as you do in the flatlands," said Sharp.

Next, the local community got to work and passed a hillside ordinance that requires any property developed on an over five percent slope to have: an engineered erosion control plan; appropriate winter cover crops; and setbacks from forests and creeks, among other things. As a result, Sharp calls Napa "the most regulated agricultural community in the state, perhaps the nation, with over 14,000 acres of hillside vineyard under erosion control plans." In the early 2000s, the water board launched their TMDL process and began studying the multitude of factors that limit salmon and steelhead production in the Napa River watershed.

At the same time, the community continued to voluntarily form watershed management groups, implement fish-friendly farming practices, and develop a program called "Napa Green." According to Sharp, "They wanted certainty and some control of their own destiny, they wanted to get ahead of more regulation.

As a result, according to Sharp, "in many aspects, the community is now exceeding the requirements of the sediment TMDL." Local interests are restoring thirteen miles of predominantly privately-owned Napa River frontage through public-private partnerships, removal of fish migration barriers, developing sustainability plans through a variety of third-party programs, and implementing priority erosion control projects in tributary watersheds that support threatened steelhead. More than 80 miles of habitat have been made more accessible to fish in just four years. "There have been a lot of bottom-up creative approaches because the community recognizes that sediment isn't the only problem. Many vineyard owners voluntarily rededicate portions of their land to the river to reclaim," said Sharp.

Results from five years of out-migrant fisheries monitoring demonstrate that steelhead in the Napa River are now relatively large and smolt production fairly consistent. These are good signs for the Napa River watershed, but there is more to do, said Sharp. Napa County, US EPA, and other partners are investing in development of a TMDL accounting system, for example, the success of which will depend upon cooperation from stakeholders, regulatory agencies, funders, and policy makers. "I don't think you can write a regulation that would spawn this level of effort. The greatest benefits of the TMDL were the conversations and the relationships that happened – the mixing zone between information and action."

Managing CECs: An Ounce of Prevention

By Ariel Rubissow Okamoto

Chemical Screening, PBDEs, PFOS, Wildlife Impacts, Medicine Disposal

With the marked successes of the Clean Water Act, and the resulting clean up of our sewage and industrial discharges, water quality watchdogs have been keeping their eye on the far horizon. "Rather than waiting for some new chemical to have an adverse effect, we need to be proactive about identifying the bad actors before they enter the Bay," said the opening speaker Tom Mumley of the San Francisco Bay Regional Water Quality Control Board. But regulating contaminants of emerging concern (CECs) is a challenge: more than 1,000 new chemicals and products debut in the USA every year, and few carry any warning tags of risks to the environment (see also Tracking Next Generation Pollutants). "Once they get into the system, it's difficult to link a chemical's occurrence to an effect, or trace an effect back to a chemical," said Mumley.

Luckily, California and the Bay Area have always had a penchant for taking the bull by the horns when it comes to environmental challenges. So it's no wonder the Bay Area's Regional Monitoring Program began tracking CECs, and trying to figure out how to tackle them, well before the rest of the country. According to Mumley, the program has helped the region's regulatory, scientific, and stakeholder community put together a framework to guide management and monitoring of CECs. This framework provides risk-based screening of

CECs, and then applies an appropriate management response (see Powerpoints). Mumley gave an overview of major CECs that have risen to attention as a result of the screening– including chemicals found in ant sprays, flea powders and antimicrobial soaps, among others.

One group of chemicals that appeared suddenly in RMP monitoring a decade ago, and helped jumpstart the new program of CEC scrutiny, was flame retardants. Speaking in place of Rebecca Sutton, Donald Yee from the San Francisco Estuary Institute (SFEI) noted that the region's response to the high levels of flame retardants that suddenly appeared in Bay Area seals and women offers lessons about how to be proactive in the future.

Yee started with some background about how California's very severe flammability standards led to the widespread addition of Polybrominated diphenyl ethers (PBDEs) to plastics, foam, and textiles to keep them from catching fire. "Most of us don't cut our furniture into pieces and then light a flame under it," she said, describing the basic test manufacturers had to apply to meet state requirements.

The adverse effects of this anti-flammability push began to emerge a decade ago. Cal/EPA studies revealed extremely high levels of PBDEs in people and wildlife in the San Francisco Bay Area, "among the highest in the world," said Yee. Concerned about effects on both humans and wildlife, federal and state environmental agencies pressured the major manufacturer of two of three commercial PBDE mixtures to stop production in the mid-2000s. California banned their use in 2006, and the US EPA ruled that any proposed uses of these chemicals be reviewed for safety. Production of the last commercial PBDE mixture was phased out at the end of 2013.

Yee described the RMP's work monitoring PBDEs in the Bay over the last ten years. Researchers detected these chemicals in Bay water and sediment, as well as in Bay bivalves, fish, bird eggs, and seals. "As we discovered many times before, our chemical, technological solutions come at a price," she said. "The good news is that we're now seeing declining PBDE contamination in sediment and organisms, probably as a result of the state ban and federal phase-outs. The bad news is that we haven't learned our lessons, so the main response to the phase out has been to replace PBDEs with other chemicals. It isn't completely clear yet what these are, but the game of playing catch up feels familiar."

Indeed, the RMP has already detected some of the alternative flame retardants replacing PBDEs in the local aquatic ecosystem. "The only way out of this loop is to really think about whether we need these chemicals in the first place, through careful consideration of how we write the standards that virtually demand their use. Fortunately, the proposed new standards are backing off the open flame test," noted Yee.

While repelling flames could be said to benefit human safety, repelling stains has always been more of an aesthetic priority. Stain repellents added to carpets, furniture, jackets, and even popcorn bags only began to concern water quality watchdogs as a CEC in the 2000s. But they've been around a lot longer, explained third speaker Meg Sedlak, also from SFEI.

Manufacturers have been adding perfluorooctane sulfonate (PFOS) to soft furnishings, fire-fighting foams, metal finishing processes, and insecticides since the 1940s. "They're great stain repellents, excellent surfactants, and good wetting agents because they repel both oil and water," said Sedlak. They're also highly stable. "They're so persistent, and so widely used for some many different applications, they've even been turning up in relatively pristine locations like the Arctic," she said.

In the Bay region, Sedlak was interested to find PFOS in apex predators such as seals and bird eggs as part of the RMP monitoring. "It remains elusive as to why concentrations in the South Bay are higher than the north," she said. Sedlak showed slides of their monitoring results: eggs collected in the South Bay in 2006 and 2009 contained levels of PFOS above a threshold for impacts on offspring survival in birds (greater than 1,000 ppb). But more recent PFOS egg results in the South Bay (2012) held a surprise. "They were 70 percent lower than prior levels, and although they have declined they may still be of concern based on recent USGS studies of tree swallows," she said.

The news has not been so rosy for seals. In collaboration with The Marine Mammal Center, the RMP analyzed harbor seal blood for PFOS and found that concentrations since 2006 exhibit similar spatial trends as for bird eggs, but no declines. "It's a mystery why one part of the Bay has different concentrations from another, and why birds are better off now but seals not," said Sedlak. "It may have something to do with different diets or longer half-lives of these compounds in seals."

Sedlak spent the balance of her talk exploring different possible pathways by which these compounds might be entering the Bay, from runoff to wastewater discharges, sediment and the food web. She also discussed the possibility that precursors may be degrading to PFOS. "At present, we just don't know the pathway by which these compounds enter the Bay food web. It's likely all of the above," she said.

One direct pathway for contaminants has always been the wastewater discharged by sewage treatment plants. Alarmingly, many of the medicines and birth control pills people ingest, or throw in the toilet once expired, are taking this route right into the water.

Speaker Francesca Vietor, with the San Francisco Public Utilities Commission, cited an SFEI report listing 44 different pharmaceutical compounds or metabolites detected in San Francisco Bay sediment or mussel samples. "These compounds are not natural, they're synthesized and produced for people. Studies show these drugs disrupt fish reproductive cycles and hurt Bay ecology. And with all the antibiotics we're adding to the environment, we're essentially cultivating drug resistant bacteria," said Vietor.

SFPUC has tried various things, from collaborating on collection events with Walgreens and the Bay Area Pollution Prevention Group to sending out pre-paid disposal envelopes upon request. In a pilot program funded by industry to increase the convenience of proper disposal, the PUC worked with 23 pharmacies and police stations to collect nine tons of unwanted pharmaceuticals in 2012.

"We need to educate people not to flush expired drugs or throw them in the trash, especially since sewer facilities are not designed to remove these compounds, and landfills can leach compounds into the Bay. And we need medical professionals and patients to understand the impacts of their reliance on prescription meds downstream. But education alone isn't enough, without sustainable disposal options. We need more funding to make these options convenient and safe," said Vietor.

Part of the funding shortfall is that it isn't quite clear who is responsible for the problem. "If the responsibility falls to the government and the utilities, then public resources are forced to pay for solutions," she said. And while non-profits and non-governmental organizations have broadcast the problem, they do not have the necessary resources to take on disposal. This leaves the private pharmaceutical companies that are making billions of dollars in profit each year, said Vietor: "Simply put, we need to adopt a new approach that promotes extended producer responsibility, a cradle-to-cradle design."

Building Resilient Baylands

By Joe Eaton & Ariel Okamoto

Habitat Goals, Climate Change, Wetland Planning

When the Bay's brightest wetland scientists and planners parted the waters back in the 1990s – laying out a bold vision for 100,000 acres of tidal wetlands to save endangered rails and mice – little did they know what awaited them on the far shore: more water. But as the next generation of wetland warriors wades into an ever deepening and widening Bay, the work done in the last 20 years to reach the *Baylands Ecosystem Habitat Goals* has certainly given our shorelines some wiggle room. And it's also given those who manage and protect them a lot of field experience and bright ideas about how to tackle the next set of challenges — which they shared in an afternoon conference session on future solutions.

"It's a growing body of water, not a static thing like a mountain," said first speaker Robin Grossinger, who has reconstructed its historical ecology and transformation for the San Francisco Estuary Institute.

The Bay was born when Pleistocene glaciers melted and the sea invaded coastal valleys. After a century of human tinkering shrank it by a third, it's getting bigger again, he explained. As the oceans swell with melted ice and the sea level rises, people and marshes will need to move inland, but "The marshes have mechanisms for that," he said. "And we do have higher land — we're not Southern Florida — but we've restricted or restrained most of what would make this a resilient system." Grossinger urged the audience to set aside the mindset of 'fixing' our shorelines, which has usually been accomplished with concrete, in order to make them adapt. Strength can also be found in flexibility, and in finding new ways to use nature's palette, he said. "We need integration between nature and engineering that we've never had before. No standard approach will work everywhere, " he said.

Certainly the original goals report took a far from standard approach. "The Goals are more than a cookbook," said the second speaker, geomorphologist Jeremy Lowe of ESA PWA and a member of the team crafting the Goals update. "We're not going to design the

Bay in one go. Instead, we hope the revised Goals will start a dynamic discussion about a dynamic system. Otherwise we'll just end up putting in a lot of concrete."

First and foremost, Lowe said, we need to figure out what restoration is appropriate where in the Bay, taking into account not only historical ecology but also future possibility. It's not just a matter of geography, he said. It's also about location, space, sediment, water, permits, and money, all of which constrain restoration. "We need to think about not only where are, but also where should there be, a beach, a delta, a creek on our shore? We need to look for opportunities to trap sediment and use wastewater, and for places where we have land bayward of the levees. We need to enhance wetlands and transition zones, and realign infrastructure," he said, clicking through slides showing local demonstration projects and shorelines where the opportunity for experimentation awaits. Lowe also suggested that everyone in the room had to broaden their job description and become "renaissance shoreline managers." Only by being engineers, geomorphologists, ecologists, insurers, investors, and planners all at once, he said, can we take on unprecedented tasks like moving neighborhoods and cities out of the way of an encroaching Bay.

After the two bigger picture perspectives, scientist Letitia Grenier got into the details of how the updated Habitat Goals – slated for release later this year– can inform planning and debate in the decades ahead. "This is how we want this race to go, and how we want to win it. We're trying to come up with the science to help people solve problems," she said. Grenier serves as coordinator for the hundred-plus scientists and resource managers who are working on updating the Goals.

In her presentation, Grenier recapped the dramatic successes since the original report in 1999: 8,000 acres restored to tidal action, another 30,000 in the planning stage, significant increases in funding, policy changes. The scale of individual projects has also expanded, she said. Pre-Goals, the largest restoration was 350 acres; now it's 15,000. The new goals acknowledge drivers of change like sea level rise and shifts in precipitation, sediment supply, freshwater inflow, salinity, and nutrients. New goals will include place-based specifics and the evolution of habitats over time, with science chapters building on conceptual models of landscape change and addressing risks to native wildlife.

With the help of onscreen charts and lists, Grenier covered the overarching recommendations in the Goals update. These include maximizing use of sediment and freshwater as resources for resiliency; building heterogeneity and gradients into restoration design; coordinating implementation of the Goals' vision via adaptive management; planning for catastrophic events so responses will address ecological interests; and partnering with educational organizations to get the message out to the public. As we race against time and tide to restore baylands, she said, we have to remember it's important to plan for many possible futures. "Uncertainty in some of the science shouldn't hold us back. If you're uncomfortable with the uncertainty of the future, this report will help," she concluded.

Following Grenier, some of the participants in the Goals update took part in a panel discussion on ways to increase ecosystem resilience as environmental conditions change. "Sea level is going up and the bay sediment supply is going down, so we need our watersheds to deliver sediment to the marshes," said John Bourgeois, manager of the South

Bay Salt Pond Restoration Project. "Lots of the decisions we'll face are going to be tough, so we need a lot of lead time."

Wildlife will need lead time too. Climate change is going to make other stresses on wildlife more intense. "We need to prioritize what's going to get hit, what we do about it, and get the fire trucks ready," warned scientist and panelist Bruce Herbold, formerly with USEPA. "But it's not just about fighting fires. We need a vision of what wildlife we want to live here, and what can live here."

Living here will depend, of course, on the state and extent of habitats for birds, fish and other wildlife in the future. Point Blue Conservation Science biologist Nadav Nur advocated a landscape scale perspective encompassing habitat connectivity and corridors for wildlife. "We can't just look at habitats in isolation. We have to look at adjacent habitats, and allow for the movement of plants and animals.This means providing refugia in the short term and increasing the resilience of wildlife populations in the long term," he said.

One critical factor in any fight for resilience will be the existence of transitional zones between baylands and uplands, and between old and new habitats — a zone now dense with human population. "There's a whole lot of infrastructure packed into the transition zone, so there's not much of the historical zone left," said panelist Josh Collins of the San Francisco Estuary Institute. "We may need to get out of the way. We may need to fill in part of the Bay to save the Bay."

Indeed we may need to do a lot of innovative things to save the cities and farmlands up and down the Estuary watershed from the big changes – intended and not – threatening the status quo. Among the known unknowns, according to panelist Wim Kimmerer of San Francisco State University's Romberg-Tiburon Center, are the answers to these questions: When will levee failures happen in the delta? When will the twin tunnels get built? How will system behave afterwards? "It's not predictable," said Kimmerer. "In the delta, a big levee collapse could be the next big extreme event. So we need a robust system where we can undertake experimental actions and investigations. We need to figure out how much does it matter if the Delta gets a lot saltier than it is now?"

"If we could translocate some of what we've learned in the Bay, and in the Habitat Goals process, to the Delta, we could all win," commented Herbold.

Panelist Donna Ball, from Save the Bay, echoed the value of education and learning in adapting to rising seas and new extremes: "We want to think of resiliency not just in the environment, but in people too. People are slow to accept change, so we need to help educate them." But creating and sustaining a healthy ecosystem will demand more from people than acceptance. As panel moderator Matt Gerhart of the California Coastal Conservancy put it: "We're still going to have to clean up our room, with or without climate change."

After a break, conference presentations got into the nitty-gritty of how to save our hard-won wetlands from rising seas. Presenters explored ways to avoid constructing giant

walls or monster gates to keep the water out, focusing instead on nature-based approaches to shoreline resilience.

Coastal ecologist Peter Baye and Bay Conservation and Development Commission geologist Sarah Richmond discussed various nature-based lines of defense against coastal flooding and erosion, ranging from wetlands to coarse sand beaches, transition zones and redesigned stream mouths. All of these rely on some human enhancement of natural processes to get a head start.

According to Richmond, sediment is the building block for marshes to stay high and wide, and marshes can still receive sediment from both Bay tides and upland streams, even if the Bay's enormous legacy supply from hydraulic gold mining has washed out. "Marshes are sandwiched between dynamic estuarine and terrestrial processes," explained Richmond. "We can restore these processes and maintain marshes through engineering."

Marshes can also buffer shores from waves. Richmond described BCDC's Innovative Wetland Adaptation Techniques Project, which studied how baylands reduce wave height and energy in Lower Corte Madera Creek Watershed. At low water levels, for example, a 1-foot high wave offshore may only be 0.2 feet high by the time it reaches the marsh edge, Richmond said. Deeper water diminishes the "mudflat muscle" to knock down waves, however, and requires a wider marsh to provide flood risk reduction.

Baye described how barrier beaches can occupy the same position as bayfront levees and address the ongoing erosion of Bay marshes. Yet, 1.5 million cubic yards of coarse sediment is mined annually, making it unavailable for marsh restoration. He used Aramburu Island in Richardson Bay – which was being eaten away by wind and wave energy — as a case study and outlined the restoration process there. "We decided to regrade the shoreline for natural beach processes, and the three-foot erosion rate ceased," he said. Aramburu's new beach was constructed with gravel, shell, cobble, and bay sand, and now provides habitat for Caspian terns and other birds. Baye also described natural and unintentional alluvial fans around the Bay that create transition zone landward of the marsh. He presented an approach pioneered by Lousiana State University researchers that uses sediment slurry from hydraulic dredging for building high marsh. Such results indicate potential wider application of these new engineering approaches in keeping ahead of marsh subsidence and wave erosion, he concluded.

The next speaker, BCDC's Joseph LaClair, discussed the challenges of aligning regulations to restoration. "Environmental legislation has been reactive, not forward-looking," he said. "No single agency is charged with protecting the Bay ecosystem. Collaboration is the key to avoiding siloed regulations for water, species, and other resources." He cited examples of successful interagency collaboration, notably the Baylands Goals project; the Montezuma Wetlands, Hamilton Field, and South Bay Salt Pond restoration efforts; the Bay Restoration Authority; the Long Term Management Strategy for dredged sediment; the Joint Policy Committee on climate change; and the Adapting to Rising Tides project. The task now is to create strategies for shoreline resilience and infrastructure protection. One possibility: a restoration design review board to integrate monitoring data and scientific review. Since climate change is happening so rapidly, there's also a need to

define thresholds for policy changes in order to respond faster. "The Bay Area has been a leader in planning for climate change," he concluded. "We need to retool our regulatory processes for responding to sea level rise while protecting the most important habitats, people, and places."

Wrapping up the session, a second panel considered opportunities for, and barriers to, nature-based adaptation. "We need to focus on goals and how best to accomplish them, and to identify regulatory challenges early," said San Francisco Bay Regional Water Quality Control Board Executive Officer Bruce Wolfe. "It's best to develop multi-benefits approaches and implement no-regrets projects." One such approach, Wolfe pointed out, involves reusing wastewater in wetlands; another, widening flood plains on the Napa River by constructing high marsh and a more sustainable stream channel.

"Larger-scale conservation planning is better," followed up US Fish and Wildlife's Cay Goude. She assured the audience that one important policy level tool, a recovery plan for tidal marsh species, will be released soon. "FWS is about habitat, not single species," she explained. "We focus on what we can do." Goude went on to describe one success story: "At Antioch Dunes, we're dumping sand from dredging the ship channel onto the dunes, building up the homes of endangered plants and insects." Then Anne Morkill of the Don Edwards San Francisco Bay National Wildlife Refuge described her agency's role as stewards of diked baylands: "Our mission is wildlife first. Ecosystem restoration relates to wildlife conservation."

Several panelists then mentioned that such missions are challenged by permitting and funding constraints, especially funding for monitoring. Speaking for the US Army Corps of Engineers, the San Francisco District's Planning Chief Tom Kendall said the Corps had lifted restrictions on adaptive management and monitoring. "Times are tight in terms of funding," Kendall said. "We have to find ways to do what we want to do more effectively."

Delta Economics and Ecosystem Management

By Chris Austin

Cost-Benefit Analysis BDCP, Stakeholder Perceptions, Adaptive Management

The Delta is many things to many people. This idea helps explain divergent views of how the region's habitats should be managed, but also fuels arguments over how best to resuscitate Delta ecosystems while slaking California's thirst for water. A Wednesday afternoon session on how social factors affect Delta management began with a panel discussion on the economics of the controversial Bay Delta Conservation Plan. The panel featured California Deputy Secretary for Natural Resources Jerry Meral and Jeff Michael, director of the University of the Pacific's Business Forecasting Center.

Michael described the BDCP as the most expensive water infrastructure project in California history. He asserted the costs are simply too high, especially for agricultural contractors who will use most of the water, and challenged the state to do a more rigorous cost-benefit analysis. According to his own analysis, the costs of the water developed could range from $541 to $9,000 per acre foot (see Powerpoint Gallery). "Everyone has a different

baseline for comparison, but no one is using the no-tunnel alternative as a baseline, which might be better for the fish," he said.

Despite the $15 billion estimated cost of the infrastructure improvement package, Michael said water agencies are arguing that it will be worth it because of the value of the regulatory assurances it could provide—a point Michael considers overstated. "As you increase or strengthen assurances to one of the stakeholders in the Delta, you aren't necessarily reducing risk as a whole; you're shifting risk between the parties," he said.

Yet state analyses of the plan's economic impacts indicate it will provide extensive benefits, said Meral, especially in the arena of ecological conservation. While the cost of new facilities and mitigation will be high, he said, agricultural water users so far have indicated they are willing to foot the bill. Viewing the project solely through an economic lens is shortsighted, Meral said. "The idea of preserving these species to me is not an economic reason; it's a moral and an ethical one." The final specifications of the project have not been settled, Meral pointed out, but its most important feature is whether it will help reverse the Delta's ecological collapse. "Part of this is a political discussion with people in the Delta, part of this is that the contractors have to pay for it, but the most important part is that the fish agencies have to permit it," said Meral. "If they see an operation that exports the kind of water that we'd like to see exported but is not producing ecological benefits, we won't get a permit."

When seeking to turn a big project like the BDCP into reality, public consensus is critical. To find out whether people agree on the cause of the Delta's decline, or the most promising means to fix it, the Public Policy Institute of California (PPIC) conducted a survey of scientists and stakeholders as part of the research project Stress Relief: Prescriptions for a Healthy Delta. The PPIC's Ellen Hanak shared results from the summer 2012 survey. Participants were given a list of five broad types of Delta ecosystem stressors (fish management, flows, invasive species, physical habitat, pollutant discharges) and asked to rate the impact each factor had on the decline of the Delta's native fishes. Participants agreed that every type of stressor was somewhat important. However, stakeholder responses depended largely upon their economic interests. "On the whole, we thought it was a positive story in the sense that everybody agreed, in a confidential survey when they do not have to grandstand, that every stressor matters," Hanak said. When asked to rate the potential effectiveness of different actions to improve conditions for the Delta's native fishes, the scientists agreed that habitat restoration and improvements in flows could aid Delta ecosystem health, but were more divided about the use of conservation hatcheries or predator harvesting, as well as the usefulness of building tunnels to reroute water or using gates to steer fish. Stakeholder views were more varied, but once again fell along economic lines. "Although they were instructed not to think about the economics, but just the fish, it's much harder to do when you know that the economics are going to affect you directly," Hanak said. The opinions of state and federal agency stakeholders and environmental advocates aligned most closely with the scientists' views, while the opinions of water exporters and upstream interests had the least correlation. Hanak considers this state of affairs a recipe for combat science and litigation. "The groups that would bear the cost tend to disagree mostly with the scientists," Hanak said. The solution? The PPIC recommends that all parties pool their funds to pay for Delta research, and together determine the

questions to be answered. Keeping the science transparent and independent, rather than designed for courtroom use, should help all parties come to more workable solutions for the Delta ecosystem, Hanak said.

The future will bring habitat restoration to tens of thousands of acres of the Delta. To ensure this massive and critical experiment will succeed, adaptive management—conducting ongoing evaluations of results and making subsequent decisions based on what has been learned thus far—is considered the key to success. One problem: adaptive management has yet to be practiced on this scale. Jay Lund from UC Davis Watershed Sciences discussed how to make this style of management work for the Delta. Features such as current conditions and land uses dictate what types of habitat restoration are possible. In the Delta, Lund pointed out, elevation is destiny. The Delta tends to be considered a uniform place, but it's not, said Lund. "We need to tailor the management of the science to the different regions and the different objectives of each region," he said. Scientists may view adaptive management as driven by science, but it's mostly about management, said Lund. Each adaptive management decision will start an experiment involving millions of dollars of gains and losses for different stakeholders, he said. For that reason, each choice must be approached carefully. Lund sees more opportunities to apply adaptive management at the project or site scale, but not Delta-wide due to prohibitive costs and regulations. Regulations have the potential to slow any adaptive management process, Lund said, so a new framework is needed to allow adaptive management to occur. But Lund considers the most difficult problem to be obtaining agency cooperation on science and adaptive management. "If we don't figure out how to work together, we're going to end up in a much worse place."

One Delta, One Science

By Paula Trigueros & Ariel Okamoto

Connecting Science to Management, Open Science Community

Using science to make good management decisions in the Delta has never been straightforward. To begin with, there are a lot of different flavors – from stakeholder science to agency science to federal, state or university science, and the kind of science used in courtrooms. There's also the complexity of any science related to a dynamic aquatic system, and the high stakes of any science used to justify taking scarce water away from one user and giving it to another. Synthesis and coordination of all the science has been a priority for decades now, but hasn't yet reached the threshold of clarity that everyone seems to be waiting for. Just how much science do we need, then, for California to feel comfortable investing in big, expensive upgrades to Delta habitats and infrastructure?

Such questions were no doubt on the minds of those in the room for the Wednesday afternoon session on the Delta Science Plan. The Delta Stewardship Council approved this plan in October 2013, just before the conference, Peter Goodwin explained after stepping to the podium. Goodwin is the top scientist for the Delta Science Program. "The science program doesn't do science, it facilitates science," he explained.

The Program's new plan lays out a vision for One Delta, One Science—an open Delta science community that works together to build a shared body of scientific knowledge. The idea is to help differentiate between genuine disagreements about what the data tell us from uncertainties associated with the information. Once that's sorted out, the Delta Science Plan suggests ways to collaboratively reduce uncertainties until tradeoffs among alternative actions become clear.

"The current organization is inadequate; collaborative science is a better [approach]," said Goodwin. "The challenge is, as the knowns grow, so do the unknowns. That's why our plan provides a menu of decision tools, including papers, panels, and workshops. Synthesis figures heavily throughout."

Goodwin yielded the microphone to Delta Science Program manager Rainer Hoenicke, who introduced a panel of prominent Delta science producers and users to discuss how to move forward with a joint science agenda. Hoenicke began by commending several current programs for providing an excellent foundation for increased collaboration, citing the Interagency Ecological Program, California Fish and Wildlife's Ecosystem Restoration Program, the California Water Quality Monitoring Council, and a series of synthesis workshops sponsored by the State Water Resources Control Board, among others. Despite the close working relationships of many individual scientists and coordinated efforts, it is difficult to track all activities related to data generation, model development and calibration, new results, and insights gained, he said. Hoenicke was confident, however, that the new science plan would create a shared process for prioritizing research, managing conflict, building trust, synthesizing science, and advancing the state of knowledge for the San Francisco Estuary and its watershed.

Hoenicke asked the panel to comment on how to make science-based adaptive management more effective. Adaptive management was conceived in the 1970s to provide for management in the face of uncertainties and new information, explained panelist Anke Mueller-Solger, lead scientist for the IEP. The process often starts off well, but fails when those attempting it don't have means or time to complete the final phases of evaluation and adaption. "We need a way to close the loop," she said.

The next panelist, Mike Chotkowski of the U.S. Fish and Wildlife Service, had this perspective: "The problem in the Delta is that scientists don't agree on the facts, on the uncertainties, or how to move forward." Economic and ideological positions tend to distort the science, he said, citing new opinion surveys (see Delta Economics story). "If we are to succeed with one science, we must move away from managers and stakeholders. We need a science establishment that can bring all sides together," he said.

The relationship between stakeholders and science has always been problematic, especially when it comes to endangered species management. "The process of remand of biological opinions shows disagreement over facts," said the next panelist, Carl Wilcox of the California Department of Fish and Wildlife. "The challenge is to find ways to overcome these disagreements using the Science Plan processes."

Many disagreements derive from uncertainties, and uncertainty helps maintain the status quo, even if it isn't working. "Managers don't do a good job of communicating gaps and needs to scientists," said the next panelist, Maria Rea of NOAA Fisheries. "We need to help researchers focus on the most relevant issues, and provide safe places for scientific debate—out of courtrooms," she said. "Science cannot give us all the answers. We also need to better communicate the underlying legal structure that guides agency decision making."

Money also plays a role in how science is used to make management decisions. The good scientific research and analysis required to set priorities often requires significant funding, said panelist Paul Helliker of the California Department of Water Resources (DWR). Together, DWR, the U.S. Bureau of Reclamation, and their water users fund the lion's share of Delta science, but this expense competes with other priorities. "We need more coalitions and collaboration [to get by], but trust is not great between agencies, and between agencies and stakeholders," said panelist Sue Fry of Reclamation. "Agencies must model trust for stakeholders, and build coalitions using the open nature of the Science Plan. We need a mutual understanding of our end points."

The U.S. Geological Survey's Lee Case agreed that collaboration must be fostered both "internally and externally." Many scientists are also concerned about federal and state funding cuts punching holes in important data sets used for management. Snapshots aren't good enough to answer questions over time, he said, so scientists need to anticipate and communicate what's ahead, rather than just focusing on writing up end results. "We need new ways of doing research that can help us simplify and communicate a very complex system," said Case.

Hoenicke then asked the panel to share their priorities for science action. Wilcox felt priorities should be issues in court: spring outflow and longfin smelt. Rea's priority was the low survival rate of outmigrating salmonids. "We don't have good life cycle models, or good synthesis of how to use tools like salinity, temperature and flows" to help the fish, she said.

Chotowski got the last word in, on sustaining Delta science over the long term: "It's hard to address complex issues without adequate resources. Agencies tend to answer science questions that are relevant to immediate management needs but not invest in answering the hard, big-picture questions about how the Estuary works."

Sharing Our Stories of the Estuary

By April Kilcrease

Cultural Landscapes, Oakland Museum Exhibit, Year of the Bay

A recent survey found that 80 percent of Californians don't know anything about the Sacramento-San Joaquin River Delta. It's a stark example of why museum curators, scientists, and environmental planners packed Tuesday afternoon's session, "Sharing our Stories: Interpreting the Estuary." In the case of the Delta, asked moderator and climate change consultant Will Travis, "how can we tell compelling stories about something the public can't find, because they don't know what to look for, why it's worth finding, and what it is if they stumble upon it?"

Chuck Striplen, an environmental scientist at the San Francisco Estuary Institute reminded the audience of the value of adding cultural landscapes, especially those from Native Americans, to public information about the Bay. According to Striplen, to fully understand the Bay as a cultural landscape, we need to build trust and promote collaborative research with local Indian tribes. "Humans have transformed the physical and ecological systems of the Bay throughout its history. Over that time, tribes accumulated tremendous knowledge and experience," he said. As evidence of this relationship, Striplen cited the shoreline shellmounds that archeologists excavated in the 1900s. The mounds are the result of more than 5,000 years of continuous human habitation on the Bay's edge. "They contain physical evidence of people's stories—their food, ceremonies, tools, arts—and they have great potential to help us understand biodiversity, disturbance response, baseline populations, and distributions of hundreds of species," said Striplen. "There remains much to be learned about the whole human experience of this place from the remnants still in the ground and in the minds of living tribal people. This history still has value in understanding how the world works and how it could work," he said. The Oakland Museum of California's interpretive exhibit about the Emeryville Shellmound is a fine example of how to share this knowledge with the public, Striplen said. "The mounds are presented not as stale, musty collections of stone and shell artifacts, but instead focus on the builders—who they were and how they lived and how the families were and are connected to this place," said Striplen.

The shellmound exhibit is part of the museum's latest major show, "Above and Below: Stories from the Changing Bay." The next two speakers discussed how staff from the museum and the San Francisco Estuary Institute worked together to bring Bay history to life. "We wanted to approach this heavily urbanized estuary not as a place where there is no nature, but as a place where people have had many different relationships with nature over time—a place that is the product of both human intervention and engineering and also the natural world and natural processes that are still current and active," said Louise Pubols, a senior curator of history at the museum of California. Pubols described the origins of the Bay Bridge portion of the show, which includes not just its construction challenges but also the experiences of commuters and bridge workers. CalTrans sponsored the exhibit to help satisfy mitigation responsibilities for the demolition of the bridge's eastern span as required by state and federal law for the destruction of large landmark structures. The exhibit's many interactive items include a giant satellite image of the Bay covering the floor ("Everyone looks for their house," said Publos); pieces of the bridge, cannonballs that have washed up

on Angel Island; and a wall covered with jars of contaminated Bay water. "We tried to think about ways to convey information without putting the book on the wall," said Publos. "No one will stand there and read five paragraphs of ten-point text. You have to catch their eye and trick them to read stuff."

Museum staff worked closely with the San Francisco Estuary Institute to integrate science into the show. "To the Oakland Museum staff, our attempt at simplifying information must have seemed anything but," said Ruth Askevold, senior project manager at the Institute. "SFEI often tells its stories in detailed technical reports. We had to learn how to translate our complex reports, charts, and tables into captions suitable for museum displays." She exhorted scientists to work harder to get the public excited about the Bay through storytelling. "Stories are one of the best ways humans, including scientists, understand, pass down, and preserve our collective knowledge. When they are done well, we walk away with a framework that helps us remember. And because stories usually involve living things, they give us a way to connect to a place and to each other," she said.

The next speaker, the Delta Protection Commission's Alex Westhoff, discussed the concept of the "Delta as place" and the need to share these site-specific stories. "The Chinese proverb, 'When you drink water, consider the fountain,' rings true when applied to the Delta," he said. To help ensure that the Sacramento-San Joaquin River Delta's unique cultural and natural resources are protected, he said, Senator Dianne Feinstein and Representative John Garamendi have proposed designating the Delta a National Heritage Area. "While its importance as a water supplier for California cannot be understated, that is just a portion of the Delta's story," said Westhoff. "What about the stories of the Delta as a cultural landscape? The stories of the Miwok Indians who inhabited the riverbanks prior to the Spanish missionaries? Of the Chinese immigrants who hand-built the first set of Delta levees using wheel brigades? Of the fourth-generation farming families who continue to grow crops on the same lands that their great grandparents did?"

Mike Moran, a naturalist with the East Bay Regional Parks District, described how the district is making the Delta a real and specific place to people at Big Break Regional Shoreline. The district built a new visitor center at the park as well as the Delta Discovery Experience, a 1,200-square-foot interactive scale map of the Delta. "The bounty that is the Delta is impossible to present, but begs to be examined. That's what we want people to do—to define their own place, their own Delta," he said. Moran argues that people need to feel a direct connection with the Delta as a place in order to care about it. "With the Delta, we often hear about its relevance to other places," he said. "But without a site to experience, a way to make it your own, the situation is sterile. It is all about the experience, the provocation, the place. That leads to an informed citizenry that will steward this place into its future," he said.

Photographs are another powerful way for people to connect with place. Anthea M. Hartig, the California Historical Society's executive director, talked about her organization's "Year of the Bay" collaboration with the website Historypin. The project allows people to upload and geotag photographs. In a little less than a year, she said, approximately 2,500 pieces of original material, mostly photographs, have been added to the site. "The broader hope of the project was that participants would help generate useful, accurate, meaningful

metadata for archival sources," Hartig explained, supplementing historic documents that have with little or no identifying information. She added, "The history of the Bay has long been dominated by relatively hegemonic standard environmental narrative. We hoped that our project would enhance, enrich, and even complicate that narrative. In the end, it comes down to garnering our stories, one beautiful person at a time."

Scaling up from Reach to Region

By Joe Eaton

Steelhead Habitat, Watershed Monitoring Tools, IRWMP

To some, the Bay's tributary creeks are primarily nurseries for fish; to others, they're potential flood emergencies affecting multiple cities and counties. Both perspectives, one focused on an individual waterway, the other concerned with the welfare of the region, are useful ways of viewing the functionality and health of a watershed. In Wednesday afternoon's "Scaling up to Sustainable Watershed Management" session, speakers looked at watersheds from angles ranging from the reach to the region, and considered how each scale addresses different aspects of watershed management.

Jonathan Koehler of the Napa County Resource Conservation District focused his talk on the stream level, analyzing how steelhead use the Napa River. The Napa has been designated an anchor watershed for steelhead *(Onchorhynchus mykiss)* and is second only to the Sacramento/San Joaquin system in stream miles accessible to the seagoing trout. Using a rotary screw trap to detain passing fish, Koehler's agency and its partners have monitored outbound migrant steelhead in the Napa River system since 2009.

Their data shows steelhead traffic peaks in early April and increases during storm flows. Napa River steelhead smolts, or juveniles, have been relatively large, predicting good ocean survival. Catch rates have remained consistent despite rainfall variations between sampling years. The picture is less encouraging for Chinook salmon. "Abundance has fluctuated substantially during the past five years of monitoring, suggesting that the Napa River population is relatively small and unstable," Koehler said. This year the conservation district began a passive integrated transponder (PIT) tagging program, using an antenna in the lower river to automatically register the passage of any fish implanted with an electronic identifier tag. The fish monitoring program helps demonstrate when the fish need strong flows, where smolts are hatching in the watershed, and how fish passage and marsh restoration projects affect fish populations, Koehler said. "This unprecedented effort has demonstrated the value of current, scientifically-sound, fisheries data to policy makers and provides a baseline by which we can measure the long-term ecological effects of ongoing restoration work."

In a presentation that dovetailed with Koehler's, Gordon Becker of the Center for Ecosystem Management and Restoration (CEMAR) discussed how smolt outmigrant monitoring can identify high growth habitat for steelhead. Trapping has helped pinpoint these areas and inform restoration efforts targeted at specific reaches within a stream. While prime habitat areas for steelhead face continuing threats, there's potential for expanding the availability of such habitat and improving its quality. "With smolt trapping data from various

Bay Area watersheds, we can better define the high-quality habitat that we're most interested in protecting," Becker noted. "The greatest numbers of steelhead smolts appear to derive from stream reaches with higher, perennial flows. These areas should form the focus of an overall program to protect the highest productivity aquatic habitats around the Bay Area." The data could direct attention to previously unexamined streams and encourage regional planning for conservation and rehabilitation of aquatic habitat. Becker suggested that issues like dry season flow impairment and channel and bank modifications might be best addressed at the stream reach scale. A reach-scale approach would also help focus limited resources and be more likely to generate visible success stories.

The scale of the stream reach is also useful in evaluating the health of an entire watershed. Just as a doctor examines blood pressure and body temperature to assess the overall well-being of a patient, watershed managers can study stream reaches as indicators of how well the watershed as a whole functions. Josh Collins of the San Francisco Estuary Institute explained how reach-scale tools like the Wetland and Riparian Area Monitoring Plan (WRAMP) can help meet the challenges of assessing watershed health. WRAMP helps managers design an ideal version of their watershed by answering a single question: how much of what ecosystem services are needed when and where and why? To do so, WRAMP organizes environmental science and information technology into a comprehensive approach for planning, permitting, and evaluation of watershed health. All of these elements are viewed as progress toward integrated goals for flood control, water supply, water quality, cultural resource protection, and wildlife conservation. Wetland Tracker, the Surface Water Ambient Monitoring Program (SWAMP), and Our Coast Our Future are other helpful parts of the watershed manager's toolkit. "Successful ecosystem health care depends on knowing the target levels of the key services, organizing activities at all levels of government to achieve the targets, monitoring progress toward the targets, and adjusting them for new scientific understanding based on the monitoring results," Collins explained. Monitoring, he added, "can also help fine-tune the conceptual models that are needed for program planning and the numerical models needed for forecasting ecosystem responses." He concluded with the idea that watershed science and technology need to be tightly coupled to a system of coordinated government programs that translate the science into effective watershed health care.

San Francisquito Creek hosts one of the last remaining wild steelhead populations in Bay Area streams, and is considered an anchor watershed for steelhead restoration efforts in the South Bay. Tidal marshes at its mouth also provide habitat for protected species such as the California clapper rail and salt marsh harvest mouse. Managing this 50-square-mile watershed and floodplain, as Len Materman of the San Francisquito Creek Joint Powers Authority (SFCJPA) explained, requires juggling far more than wildlife issues. Sediment management and flood risks to Palo Alto, East Palo Alto, and Menlo Park are major concerns, as floodwaters have entered homes several times in the past, most recently in December 2012. The downstream reach of the creek offers an opportunity to reconnect a historic sediment source with marshes that contain important wildlife habitat and are in danger of being permanently inundated as a result of sea level rise. The SFCJPA's proposed solution, done in conjunction with its Strategy to Advance Flood protection, Ecosystems and Recreation along the Bay (SAFER Bay), could re-create the connection between the creek and Bay marshlands during high creek flow and high tide events. This multi-

jurisdictional project between the Bay and Highway 101, which would provide flood protection against creek flows, extreme tides that impact creek flows, and a two-foot rise in sea level, is moving towards construction this summer. "In addition to restoring 14 acres of historic tidal marshland, over half of which would come from a golf course, our proposed project minimizes flow constriction and sediment deposition in the channel and maximizes its transport to the Bay, where it could build up marshlands at the mouth of the system. In this way, people and property are protected, and our marsh habitats can naturally adapt to sea level rise," said Materman.

In a region as highly urbanized as the Bay Area, inviting local governments to the watershed planning table is not only a good idea, but produces a better plan at the end, according to Josh Bradt of the San Francisco Estuary Partnership. Comprehensive watershed planning by local government "promotes improved watershed health and function by identifying multi-benefit solutions and funding strategies" he says. "Municipal and county governments are uniquely positioned to be anchors of watershed planning and management." Bradt noted local governments have many watershed responsibilities, such as public health and safety, environmental protection, infrastructure maintenance, as well as common concerns such as undersized and deteriorating stormwater infrastructure, increasing regulatory requirements, staff and budget constraints. Developing a watershed management plan for the city of Berkeley involved an analysis of existing policies, programs, and assets, and hydrologic modeling of two of the city's watersheds—one still mostly natural, the other a paved-over "ghost drainage." The plan's recommendations carried an estimated $83 million price tag for those two watersheds, with work on the remaining eight watersheds within city boundaries costing an estimated additional $125 million. "One challenge was to identify how green infrastructure would complement existing gray infrastructure, and not compete with it for limited capital, operations and maintenance, and staff resources," Bradt explained. Green infrastructure, he said, not only increases resiliency to climate change but beautifies communities and neighborhoods, improves the curb appeal of residential properties, and fosters pedestrian safety. Funding sources for watershed plan implementation could come from a combination of local tax measures, greenhouse gas reduction funds, vehicle license fees, and state water bonds.

The institutional setting of watershed management matters, according to UC Berkeley's Louise Mozingo. The Bay Area's water agencies have a diversity of mandates in terms of water supply, water treatment, flood control, and environmental policy. Innovative urban water strategies such as greenstreets, conjunctive water management, water recycling, decentralized water treatment bioreactors, and unit process wetlands have been implemented within an existing, highly fragmented system. Even though coordination and overlap can be problematic, multiple jurisdictions do lend themselves to experimentation. The public also has a stake and a voice, expressed in a multitude of friends-of-creeks groups. "Community advocacy has focused on surface water systems, on place-making," Monzingo said, "yet we need to think of water supply, water treatment, and surface water as a single resource system." While recognizing that change in watershed management is still "an accretion of local decisions," she'd like to see place-making extended to "science-based systemic problem solving with regional benefits." To do this, jurisdictional fragmentation problems and complexities need to be addressed. Although the Integrated Regional Watershed

Management Plan is a step in this process, coordinated regional water resource management still faces significant institutional obstacles.

Closing the session, California Water Resources Control Board member Steven Moore discussed the status and future of integrated water management. The Integrated Regional Water Management legislation of 2002 helped bring institutionally isolated functions like water supply, pollution control, groundwater supply, and stream and wetland restoration together in a regional context. However, Moore said, IRWM has serious limitations; it is "match-funded by voter-approved bonds that are an unreliable source of public funding going forward, and is implemented by a fragmented governance structure lacking needed flexibility for revenue generation and expenditures." One solution might be voluntary groupings of public agencies and private organizations throughout a watershed or basin that are endowed with revenue-raising powers. Said Moore, "Regional unified water authorities could build on partnerships and experiences of existing integrated water agencies to improve the governance for all aspects of water, ensuring California can meet its sustainability goals into the twenty-first century."

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